UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

Note to Reader
January 8, 1998

Background: As part of its effort to involve the public in the implementation of the Food Quality Protection Act of 1996 (FQPA), which is designed to ensure that the United States continues to have the safest and most abundant food supply. EPA is undertaking an effort to open public dockets on the organophosphate pesticides. These dockets will make available to all interested parties documents that were developed as part of the U.S. Environmental Protection Agency's process for making reregistration eligibility decisions and tolerance reassessments consistent with FQPA. The dockets include preliminary health assessments and, where available, ecological risk assessments conducted by EPA, rebuttals or corrections to the risk assessments submitted by chemical registrants, and the Agency's response to the registrants' submissions.

The analyses contained in this docket are preliminary in nature and represent the information available to EPA at the time they were prepared. Additional information may have been submitted to EPA which has not yet been incorporated into these analyses, and registrants or others may be developing relevant information. It's common and appropriate that new information and analyses will be used to revise and refine the evaluations contained in these dockets to make them more comprehensive and realistic. The Agency cautions against premature conclusions based on these preliminary assessments and against any use of information contained in these documents out of their full context. Throughout this process, If unacceptable risks are identified, EPA will act to reduce or eliminate the risks.

There is a 60 day comment period in which the public and all interested parties are invited to submit comments on the information in this docket. Comments should directly relate to this organophosphate and to the information and issues available in the information docket. Once the comment period closes, EPA will review all comments and revise the risk assessments, as necessary.

These preliminary risk assessments represent an early stage in the process by which EPA is evaluating the regulatory requirements applicable to existing pesticides. Through this opportunity for notice and comment, the Agency hopes to advance the openness and scientific soundness underpinning its decisions. This process is designed to assure that America continues to enjoy the safest and most abundant food supply. Through implementation of EPA's tolerance reassessment program under the Food Quality Protection Act, the food supply will become even safer. Leading health experts recommend that all people eat a wide variety of foods, including at least five servings of fruits and vegetables a day.

Note: This sheet is provided to help the reader understand how refined and developed the pesticide file is as of the date prepared, what if any changes have occurred recently, and what new information, if any, is expected to be included in the analysis before decisions are made. **It is not meant to be a summary of all current information regarding the chemical.** Rather, the sheet provides some context to better understand the substantive material in the docket (RED chapters, registrant rebuttals, Agency responses to rebuttals, etc.) for this pesticide.

Further, in some cases, differences may be noted between the RED chapters and the Agency's comprehensive reports on the hazard identification information and safety factors for all organophosphates. In these cases, information in the comprehensive reports is the most current and will, barring the submission of more data that the Agency finds useful, be used in the risk assessments.

Jack E. Housenger, Acting Director
Special Review and Reregistration Division

21 May 1998

MEMORANDUM

SUBJECT: OCCUPATIONAL AND RESIDENTIAL EXPOSURE ASSESSMENT AND RECOMMENDATIONS FOR THE REREGISTRATION ELIGIBILITY DECISION DOCUMENT FOR DISULFOTON

FROM: Jonathan Becker, Ph.D., Environmental Health Scientist
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THRU: Al Nielsen, Senior Scientist
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Please find attached the occupational and residential review of disulfoton.

DP Barcode:	238096
Pesticide Chemical Codes:	032501
EPA Reg Nos.:	4-153, 4-253, 192-74, 192-126, 239-2134, 264-464, 400-408, 400-411, 400-475, 572-346, 769-850, 769-908, 802-426, 869-76, 69-223, 2935-435, 3125-83, 3125-116, 3125-172, 3125-183, 3125-307, 5481-415, 5887-61, 8660-125, 9688-94, 11474-70, 32802-32, 33955-489, 34704, 475, 34704-586, 28293-277, 42057-51, 46260-2, 46260-10, 49585-28, 59144-23, CA 92002500, CA 960014, NC 92001100, OR 91002700, TX 90000400, VA 92000600, WA 92002600
EPA MRID No.:	404690-01, 405041-05, and 422294-01
PHED:	Yes, Version 1.1

OCCUPATIONAL AND RESIDENTIAL EXPOSURE AND RISK ASSESSMENTS

(RED SECTION III, PART 3)
EXPOSURE AND RISK ASSESSMENT/CHARACTERIZATION

(BACKGROUND)

Purpose

In this document, which is for use in EPA's development of the Disulfoton Reregistration Eligibility Decision Document (RED), EPA presents the results of its review of the potential human health effects of occupational and residential exposure to disulfoton.

Criteria for Conducting Exposure Assessments

An occupational and/or residential exposure assessment is required for an active ingredient if (1) certain toxicological criteria are triggered and (2) there is potential exposure to handlers (mixers, loaders, applicators, etc.) during use or to persons entering treated sites after application is complete. For disulfoton, both criteria are met.

Summary of Toxicity Concerns Relating to Occupational and Residential Exposures

Acute Toxicology Categories

Table 1 below presents the acute toxicity categories based on the active ingredient as outlined in the Hazard Identification document.[1]

Table 1: Acute Toxicity Categories for Disulfoton

Guideline Number	Toxicity Category	MRID Number	Results	Toxicity Category
81-1	acute oral	Acc 072293 Doc 003958 P41	LD_{50}= M: 6.2 mg/kg F: 1.9 mg/kg	I
81-2	acute dermal	Acc 07793 Doc # 03958 P71 & 004223, p.24	LD_{50}= M: 15.9 mg/kg F: 3.6 mg/kg	I
81-3	acute inhalation	Acc 258569 Doc # 05789	LC_{50}= M: 0.06 mg/L F: 0.89 mg/L	I
81-4	primary eye irritation	Data requirement waived. Doc # 03958 p. 12: 004223. p14		
81-5	primary dermal irritation	Data requirement waived. Doc # 03958 p. 12: 004223. p14		
81-6	dermal sensitization	Data requirement waived. Doc # 03958 p. 12:		
81-8	acute neurotoxicity	42755801	Reversible neurotoxic signs consistent with the cholinesterase inhibition. 1.5 mg/kg in females and 5.0 mg/kg in males	

Other Endpoints of Concern

The Hazard Identification document for disulfoton, indicates that there are toxicological endpoints of concern. The endpoints used in assessing the risks for disulfoton are presented in the following Table 2.

Table 2: Endpoints for Assessing Occupational and Residential Risks for Disulfoton[1]

Test	Results
Short-term Dermal Exposure (1 to 7 days)	0.4 mg/kg/day (MOE = 100) based on a 21 day dermal study in rabbits
Intermediate-term Dermal Exposure (1 week to several months)	0.03 mg/kg/day (MOE = 100) based on a special 6 month cholinesterase inhibition feeding study
Inhalation Exposure (All-time periods)	0.00016 mg/L MOE = 100
Dermal Absorption	36%
Inhalation Absorption	100%

SUMMARY OF USE PATTERN AND FORMULATIONS

Occupational-Use and Homeowner-Use Products

At this time products containing disulfoton are intended for both homeowner and occupational uses. Residential uses include small vegetable gardens, ornamental flowers and shrubs including rose bushes and small trees and potted plants (indoor and outdoor). Occupational registrations include terrestrial food and feed crops, indoor greenhouse non-food crops, forest trees, ornamental herbaceous plants, ornamental woody shrubs and vines, ornamental shade trees.[2,3]

Type of pesticide/target pests

Disulfoton, (O,O-Diethyl S-[2-(ethylthio)ethyl] phosphorodithioate) is a selective systemic organophosphate insecticide used to control a variety of sucking insects. Examples of the type of insects that disulfoton controls include (but are not limited to) the following:[3]

- Vegetables and Field Crops: Aphids, Leafhoppers, Mexican bean beetle larvae, Mites, Thrips and Potato psyllid, Grasshoppers, Flea beetles, Southern potato wireworms, Root aphids, Green peach aphids, Colorado potato beetles, Hessian fly

- Ornamental shrubs, trees and rose bushes: Aphids, Birch leaf miner, Elm leaf beetle, European elm scale, Lace bug, Leafhoppers, Mites, Thrips, Whiteflies, Birch leafminers,

Camellia scale, Holly leafminer, Leafhoppers, Mimosa webworm, Pine tip moth, Soft scale, Spider mites, Tea scale, Thrips and Whiteflies

Formulation types and percent active ingredient

Disulfoton is formulated as a technical product (98.5 percent active ingredient), an emulsifiable concentrate (85, 23, and 17.5 percent active ingredient), and as a granular (15, 10, 6.5, 2, 1, 0.625, 0.5, and 0.37 percent active ingredient). It is often formulated in combination with fertilizers.

Registered use sites[2,3]

Occupational-use sites

Disulfoton has been registered for occupational-use on agricultural crops, ornamental flowers and shrubs, non-bearing fruit trees, and nut trees. The occupational crops use sites in this RED have been grouped as follows:

- **Agricultural Crops (food and feed crops)**, including peppers, broccoli, Brussel sprouts, cabbage, chinese cabbage, cauliflower, lettuce, spinach, asparagus, radishes, black and red raspberries, tomatoes, barley, field corn, oats, triticale, wheat, cotton, peanuts, peas, sorghum, soybeans, white/irish potatoes, dried, lima, and snap beans, lentils, sweet corn, sugar beets and popcorn and strawberries (propagating plants only) and tobacco;

- **Nut Trees**, specifically pecans growing in the south central and southwestern regions of the United States;

- **Non-Bearing Fruit Trees**, including apples, crabapples, pears, apricots, cherries, peaches, plums and prunes. Disulfoton is not applied to trees that will bear fruit during the current crop year;

- **Ornamental Flowers/Groundcover,** including annuals and bulbs;

- **Ornamental Shrubs and Trees,** including Christmas trees;

- **Potted Plants,** both indoor and outdoor**.**

Non-occupational-use sites

Potential residential and non-occupational use sites may include indoor or outdoor residential sites (e.g., exposure to insecticide use on ornamentals), professional uses at residential sites (e.g., insecticide use on trees, shrubs, and other ornamentals), and professional sites where non-occupational exposure may occur (ornamental trees, parks, residential and recreational areas). The non-occupational crops use sites in this RED have been grouped as follows:

- **Residential Ornamental Flowers**, including annuals such as ageratum, calendulas, carnations, chrysanthemums, delphiniums, marigolds, petunias, snapdragons, zinnias, and bulbs;

- **Residential Ornamental Shrubs and Trees,** both evergreen and deciduous;

- **Residential Rose Bushes;**

- **Residential Vegetable Gardens,** including green, snap, and lima beans, Brussel sprouts, broccoli, cabbage, cauliflower, lettuce and peas; and

- **Residential Potted Plants,** both indoor and outdoor.

Application Rates[2,3]

- **Agricultural Crops**: The application rate for commercial crops ranges from 8 lb active ingredient (ai)/acre to 0.5 lb ai/acre, including rates of 1.0 lb ai/acre for crops such as broccoli, Brussel sprouts, cabbage and cauliflower, 2.0 lb ai/acre for lettuce, peppers, peanuts, 2.5 lb ai/acre for peas and lentils, and 4 lb ai/acre for tobacco and potatoes.

- **Nut Trees**: The maximum application rate for nut trees (i.e., pecan trees in the southern regions of the United States) is 3 lb ai/acre.

- **Non-Bearing Fruit Trees**: The application rate for pecan trees is 0.16 to 1.56 lb per tree (EPA Reg No. 3125-172). Based on the assumption of tree plantings with 10 foot centers, (435 trees/acre), the maximum application rate to non-bearing fruit trees is therefore 102 lb ai/acre.

- **Ornamental Flowers/Groundcover:** The maximum application rate is 28.6 lb ai/acre.

- **Shrubs and Trees**: (including Christmas trees): Based on the assumption of plantings using 10 foot centers, and 2-inch trunk diameters (when measured at a height of 4 feet), the application rate to trees is 20 lb ai/acre. The application rate to shrubs is 4.3 lb ai/acre, assuming 4 foot shrub height, and 435 shrubs/acre.

- **Potted Plants:** The application rate for granular hand method applications to potted plants is 0.00052 lb ai/12 inch pot.

- **Residential Ornamental Flowers**: The maximum application rate ranges from 0.3 lb ai/1,000 ft^2 to 0.005 lb ai/1,000 ft^2.

- **Residential Ornamental Shrubs and Small Trees:** The maximum application rates for granular applications range from 1.32 lb ai/four foot shrub or tree to 0.00032 lb ai/four foot shrub or tree.

- **Residential Rose Bushes:** The maximum application rate for granular application to rose bushes is 0.00188 lb ai/bush.

- **Residential Vegetable Gardens:** The maximum application rate ranges from 0.1125 lb ai/1,000 ft^2 to 0.0313 lb ai/1,000 ft^2.

- **Residential Potted Plants:** The maximum application rate for hand application of granulars to pots is 0.00011 lb ai/six inch pot.

Methods and Types of Equipment used for Mixing, Loading, and Application[2,3]

Disulfoton can be applied with ground or air equipment using broadcast, chemigation, high volume spray, low volume spray, seed treatment, soil band treatment, soil incorporated broadcast treatment, soil in-furrow treatment (drill and hill-drop), top dressing equipment, soil injection, soil sidedress, and by hand using a shaker can, spoon, or measuring scoop. Following application, disulfoton is soil incorporated into the top 2 to 3 inches of soil and may require watering in.

- **Agricultural Crops:** Granular formulations are typically applied in the seed furrow or in a soil incorporated band on each side of the seed furrow at planting. When used as a preplanting treatment, disulfoton is applied using broadcast granular and liquid spray equipment and then soil incorporated into the top 2 to 3 inches of soil. Examples include: for cotton, disulfoton granules are applied as a soil in furrow treatment applied over seed at planting or in a soil incorporated band on each side of the furrow which is then soil incorporated; for sorghum, applications are made at planting, and then into the whorl post planting; and for barley, drilling or broadcast at planting and broadcast after emergence.

- **Nut Trees** (specifically pecans grown in states of the South Central and Southwestern regions): Granulars are applied by treating 6 foot bands of soil on both sides of the trees, followed by soil incorporation into top 2 to 3 inches of soil and then watered in.

- **Non-Bearing Fruit Trees**: Granulars are applied uniformly from trunk to drip line on all sides, soil incorporated and watered in.

- **Flowers/Groundcover:** As a preplant treatment, granular formulations can be evenly applied to seed beds by hand or belly grinder, and then soil incorporated.

- **Shrubs and Trees:** (including Christmas trees) Application is made by soil injection or soil implantation with an auger or soil sampling tool. Granules are applied as a soil incorporated broadcast treatment, or evenly spread under shrub canopy, and then soil incorporated.

- **Potted Plants:** Applications are made by hand, and then soil incorporated.

- **Residential Ornamental Flowers:** Belly grinder applications can be used for preplanting treatment, or treatments can be applied by hand using a spoon, measuring cup, or shaker can, and then soil incorporated.

- **Residential Ornamental Shrubs**: Applications are made by distributing granules uniformly under the shrub canopy by hand using a spoon, measuring cup, or shaker can and soil incorporated and then watered in.

- **Residential Rose Bushes:** Belly grinder applications can be made for preplanting treatment. At planting, or to established bushes, application of granulars is made by hand using a spoon, measuring cup, or shaker can.

- **Residential Vegetable Gardens:** Belly grinder applications can be made for preplanting treatment. At planting, or to established shrubs or trees, application of granulars is made by hand using a spoon, measuring cup, or shaker can.

- **Residential Potted Plants:** Applications are made by hand by punching a hole into soil and pouring granules into the holes or sprinkling granules on the soil and soil incorporating.

ASSESSMENT/CHARACTERIZATION

Occupational Exposures and Risks

Handler Exposures & Risks

EPA has determined that there are potential exposures to mixers, loaders, applicators, or other handlers during usual use-patterns associated with disulfoton. Based on the use patterns, 15 major exposure scenarios were identified for disulfoton: (1a) mixing, loading liquid formulations (emulsifiable concentrates) for aerial/chemigation application; (1b) mixing, loading liquid formulations (emulsifiable concentrates) for groundboom application; (1c) mixing, loading liquid formulations (emulsifiable concentrates) for orchard airblast sprayer application; (2a) loading granulars for aerial application; (2b) loading granulars for tractor-drawn spreader application; (3) applying sprays with a fixed-wing aircraft; (4) applying granulars with a fixed-wing aircraft; (5) applying sprays with a helicopter; (6) applying granulars with a helicopter; (7) applying sprays with a groundboom; (8) applying sprays to orchards with an airblast; (9) applying granulars with a tractor-drawn spreader; (10) loading and applying granulars using a belly grinder; (11) loading and applying granulars with a push-type granular spreader; (12) applying granulars by hand, with a spoon, shaker can, or a measuring scoop; (13) applying ready-to-use liquid as a seed soak treatment; (14) flagging during aerial spray applications; and (15) flagging during aerial granular applications.

Handler Exposure Scenarios -- Data and Assumptions

An exposure assessment for each scenario was developed, where appropriate data are available, using the *Pesticide Handlers Exposure Database (PHED) Version 1.1*.[4] Table 3

summarizes the caveats and parameters specific to the surrogate data used for each scenario and corresponding exposure/risk assessment. These caveats include the source of the data and an assessment of the overall quality of the data. The assessment of data quality is based on the number of observations and the available quality control data. The quality control data are based on a grading criteria established by the PHED task force.

The following assumptions and factors were used in order to complete this exposure assessment:

- Average body weight of an adult handler is 70 kg.

- Average work day interval represents an 8 hour workday (e.g., the acres treated or volume of spray solution prepared in a typical day are based on an 8 hour workday).

- Daily acres and volumes (as appropriate) to be treated in each scenario include:

    -- 350 acres for aerial and chemigation applications in agricultural settings (including flaggers supporting aerial applications)
    -- 80 acres for groundboom spraying of agricultural areas
    -- 80 acres for tractor-drawn spreader application to agricultural settings
    -- 40 acres for orchard airblast application
    -- 2 acres for application of granular formulations to orchards and ornamental flower or groundcover nursery stock using a tractor-drawn spreader
    -- 2 acres for application of granular formulations to agricultural fields using a belly grinder
    -- 350 pots (12 inch diameter) treated when applying and soil incorporating granulars by hand with a spoon, shaker can, or a measuring scoop

- Calculations are completed at the maximum application rates for specific crops recommended by the available disulfoton labels to bracket risk levels associated with the various use patterns.

- Due to a lack of scenario-specific data, HED is often forced to calculate unit exposure values using generic protection factors (PF) that are applied to represent various risk mitigation options (i.e., the use of Personal Protective Equipment (PPE) and engineering controls). PPE protection factors include those representing a double layer of clothing (50 percent PF), chemical resistant gloves (90 percent PF) and respiratory protection (80 percent PF) for use of dust/mist mask. Engineering controls are generally assigned a PF of 98 percent.

Handler Exposure and Non-Cancer Risk Estimates

Handler exposure assessments are completed by EPA using a baseline exposure scenario and, if required, increasing levels of risk mitigation (PPE and engineering controls) to achieve an appropriate margin of exposure (MOE). The baseline scenario generally represents a handler wearing long pants, a long-sleeved shirt, and no chemical-resistant gloves. The following tables

present risk assessment calculations for the handling of disulfoton. Table 4 presents the short-term and intermediate-term dermal, and inhalation exposures at baseline. Table 5 presents the dermal and inhalation risks for those scenarios at baseline. Table 6 presents the occupational short-term and intermediate-term doses and risks when wearing PPE risk mitigation. Table 7 presents the same dose/risk calculations when employing engineering controls (e.g., enclosed cab or cockpit, and packaging for closed loading of granulars).

The calculations of daily dermal and inhalation exposure to disulfoton by handlers are used to calculate the daily dose and hence the risks, to those handlers. Potential daily dermal exposure is calculated using the following formula:

$$Daily\ Dermal\ Exposure\left(\frac{mg\ ai}{day}\right) = Unit\ Exposure\left(\frac{mg\ ai}{lb\ ai}\right) x\ Use\ Rate\left(\frac{lb\ ai}{A}\right) x\ Daily\ Acres\ Treated\left(\frac{A}{day}\right)$$

The potential short-term and intermediate-term dermal doses were calculated using the following formulae:

$$Short-term\ Daily\ Dermal\ Dose\left(\frac{mg\ ai}{kg/day}\right) = Short-term\ Daily\ Dermal\ Exposure\left(\frac{mg\ ai}{day}\right) x\left(\frac{1}{Body\ Weight\ (kg)}\right)$$

$$Intermediate-term\ Daily\ Dermal\ Dose\left(\frac{mg\ ai}{kg/day}\right) = Intermediate-term\ Daily\ Dermal\ Exposure\left(\frac{mg\ ai}{day}\right) x\left(\frac{1}{Body\ Weight\ (kg)}\right)$$

The short-term and intermediate-term dermal MOEs were calculated using the following formulae:

$$Short-term\ Dermal\ MOE = \frac{Short-term\ NOEL\left(\frac{mg}{kg/day}\right)}{Short-term\ Dermal\ Daily\ Dose\left(\frac{mg}{kg/day}\right)}$$

$$Intermediate-term\ Dermal\ MOE = \frac{Intermediate-term\ NOEL\left(\frac{mg}{kg/day}\right)}{Intermediate-term\ Dermal\ Daily\ Dose\left(\frac{mg}{kg/day}\right)} * Dermal\ Absorption\ Factor$$

The short-term MOEs were calculated using a NOEL of 0.4 mg/kg/day assuming 100 percent dermal absorption. The intermediate-term MOEs were calculated using a NOEL of 0.03 mg/kg/day assuming 36 percent dermal absorption.

Potential daily inhalation exposure was calculated using the following formula:

$$\text{Daily Inhalation Exposure}\left(\frac{\text{mg ai}}{\text{day}}\right) =$$
$$\text{Unit Exposure}\left(\frac{\text{g ai}}{\text{lb ai}}\right) \times \text{Conversion Factor}\left(\frac{1\ \text{mg}}{1{,}000\ \ \text{g}}\right) \times \text{Use Rate}\left(\frac{\text{lb ai}}{\text{A}}\right) \times \text{Daily Acres Treated}\left(\frac{\text{A}}{\text{day}}\right)$$

The potential short-term and intermediate-term inhalation doses were calculated using the following formulae:

$$\text{Short-term Daily Inhalation Dose}\left(\frac{\text{mg ai}}{\text{kg/day}}\right) = \text{Short-term Daily Inhalation Exposure}\left(\frac{\text{mg ai}}{\text{day}}\right) \times \left(\frac{1}{\text{Body Weight (kg)}}\right)$$

$$\text{Intermediate-term Daily Inhalation Dose}\left(\frac{\text{mg ai}}{\text{kg/day}}\right) = \text{Intermediate term Daily Exposure}\left(\frac{\text{mg}}{\text{day}}\right) \times \left(\frac{}{\text{Body Weight kg)}}\right)$$

inhalation absorption rate of 100 percent.

The short-term and intermediate-term inhalation MOEs were calculated using the

$$\text{MOE} \quad \frac{\text{NOEL}\left(\frac{\text{mg}}{\text{/day}}\right)}{\text{Daily Dose}\left(\frac{}{\text{kg/}}\right)}$$

Both short-term and intermediate-term inhalation MOEs were calculated using a NOEL of 0.045 mg/kg/day (assuming 100% inhalation absorption) for both short-term and intermediate-

Fisher rats. This concentration was converted to a dose (mg/kg/day) using respiratory volume of 7.15 liters/hour and a body weight of 0.152 kg.

$$Dermal\ MOE = \frac{NOEL\left(\frac{mg}{kg/day}\right)}{Dermal\ Daily\ Dose\left(\frac{mg}{kg/day}\right)}$$

$$Inhalation\ MOE = \frac{NOEL\left(\frac{mg}{kg/day}\right)}{Inhalation\ Daily\ Dose\left(\frac{mg}{kg/day}\right)}$$

The total MOE was calculated using the following formula:

$$Total\ MOE = \frac{1}{\left(\frac{1}{MOE_{dermal}}\right) + \left(\frac{1}{MOE_{inhalation}}\right)}$$

Table 3: Exposure Scenario Descriptions for the Use of Disulfoton

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
Mixer/Loader Descriptors			
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) (1a/1b/1c)	PHED V1.1	350 acres for aerial and chemigation in agricultural settings, 80 acres for groundboom application, and 40 acres for orchard airblast applications	**Baseline:** Hands, dermal, and inhalation = AB grades. Hands = 53 replicates; dermal = 72 to 122 replicates; and inhalation = 85 replicates. High confidence in hands, dermal and inhalation data. No protection factor was needed to define the unit exposure value. **PPE:** The same dermal data are used as for the baseline coupled with a 50% protection factor to account for an additional layer of clothing. A 5-fold PF (e.g. 80% PF was applied to the baseline inhalation data to account for the use of a dust mist respirator. Hands = AB grades with 59 replicates. High confidence in hands, dermal data. **Engineering Controls:** Mechanical transfer method. Hands, dermal and inhalation unit exposures = AB grades. Hands = 31 replicates; dermal = 16 to 22 replicates, and inhalation = 27 replicates. High confidence in dermal, hand and inhalation data. Gloves were worn during the use of the engineering controls.
Loading Granular Formulations (2a, 2b)	PHED V1.1	350 acres for aerial application, 80 acres for tractor drawn spreader agricultural application, and 2 acres for ornamental flowers/groundcover, and trees	**Baseline:** Hands = All grade, dermal = ABC grade, and inhalation = AB grade. Hands = 10 replicates; dermal = 33 to 78 replicates; and inhalation = 58 replicates. Low confidence in dermal/ hand data. High confidence in inhalation data. **PPE**: Hands = AB grade, dermal = ABC grade. Dermal = 45 replicates, hands = 12-59 replicates. Low confidence in dermal and hands data. A 5-fold PF was applied to the baseline inhalation data to account for the use of a dust mist respirator. **Engineering Controls:** Closed loading of granulars. 98% PF was applied to baseline data.
Applicator Descriptors			
Applying Liquid Formulations (Emulsifiable Concentrates) with a Fixed-Wing Aircraft (3,4)	PHED V1.1	350 acres for aerial	**Baseline:** No data **PPE:** No data **Engineering Controls:** Hands = AB grade, dermal and inhalation = ABC grade. Medium confidence in hands/dermal and inhalation data. Hands = 34 replicates, dermal = 24-48 replicates, and inhalation = 23 replicates.

Table 3: Exposure Scenario Descriptions for the Use of Disulfoton (Continued)

	Data	Standard Assumptions (8-hr work day)	[b]
Applying Granulars with a Fixed-Wing Aircraft (4)	PHED V1.1	350 acres for aerial	**Baseline:** No data **PPE:** No data **Engineering Controls:** Hands and inhalation - All grade, dermal - C grade. Hands = 4 replicates, inhalation = 13 replicates, and dermal = 0-13 replicates. Low confidence in all data.
Applying Liquid Formulations (Emulsifiable Concentrations) with a Helicopter (5,6)	PHED V1.1	350 acres for aerial	**Baseline:** No data **PPE:** No data **Engineering Controls:** Hands and inhalation = A grade, dermal = C grade. Low confidence in inhalation data, and extremely low confidence in hands and dermal data due to very low number of replicates. Hands = 2 replicates, dermal = 3 replicates, and inhalation = 3 replicates.
Applying Granulars with a Helicopter (6)	No Data	No Data	No Data
Applying Sprays with a Groundboom (7)	PHED V1.1	80 acres in agricultural applications	**Baseline:** Hand, dermal, and inhalation = AB grades. Hands = 29 replicates, dermal = 23 to 42 replicates, and inhalation = 22 replicates. High confidence in hand, dermal, and inhalation data. **PPE:** The same dermal and inhalation data are used as for the baseline coupled with a 50% protection factor to account for an additional layer of clothing, and an 80% PF to account for the use of a dust mist respirator, respectively. Hands data are ABC grades with 21 replicates. Medium confidence in hands, and dermal data. **Engineering Controls:** Hands and dermal = ABC grade, inhalation = AB grade. Hands = 16 replicates, dermal = 20-31 replicates, inhalation = 16 replicates. Medium confidence in hands and dermal data, and high confidence in inhalation data.

Exposure Scenario (Number)	Source	[a]	Comments
Applying Sprays to Orchards with an Airblast (8)	PHED V1.1	40 acres for orchard spraying	**Baseline**: Hand, dermal and inhalation are AB grade. Hands 22 replicates, dermal = 32 to 49 replicates, and inhalation = 47 replicates. High confidence in hand, dermal and inhalation data. **PPE**: Hands and dermal = AB grade. Hands = 18 replicates, dermal = 31 to 48 replicates. High confidence in hands and dermal data. A 5-fold (80% PF) was applied to baseline inhalation data to account for use of dust-mist respirator. **Engineering Controls**: Dermal = AB grade, inhalation = ABC grade, hands = AB grade. Low confidence in inhalation and dermal data. Inhalation = 9 replicates, dermal = 20-30 replicates, and hands = 20 replicates. A 90% PF was applied to gloved data to represent no gloved scenario.
Applying Granulars with a Tractor-Drawn Spreader (9)	PHED V1.1	80 acres for agriculture and 2 acres for ornamental flowers / groundcover application	**Baseline:** Hands, dermal and inhalation = AB grades. Low confidence in hands, dermal and inhalation data. Hands = 5 replicates, dermal = 1-5 replicates and inhalation = 5 replicates. **PPE:** The same hand and dermal data are used as for the baseline coupled with a 90% PF to account for chemical resistant gloves, and a 50% PF to account for an additional layer of clothing, respectively. The same inhalation data are used as for the baseline coupled with an 80% PF to account for the use of a dust mist respirator. **Engineering Controls:** Hands, dermal and inhalation data are AB grades. Hands = 24 replicates, dermal = 27 to 30 replicates, and inhalation = 2-30 replicates. High confidence in hands, dermal and inhalation data.
Mixer/Loader/Applicator Descriptors			
Loading/Applying Granulars Using a Belly Grinder (10)	PHED V1.1	2 acres for agricultural and ornamental flowers / groundcover application	**Baseline:** Hands and dermal = ABC grades and inhalation = AB grade. Medium confidence in hands/dermal data and high confidence in inhalation data. Hands = 23 replicates, dermal = 29-45 replicates and inhalation = 40 replicates. **PPE:** = Gloved data for hands = ABC grade with 15 replicates. The dermal data are taken from the baseline coupled with a 50% protection factor to account for an additional layer of clothing. A 5-fold protection factor (80% PF) was applied to baseline inhalation data to account for use of dust mist respirator. **Engineering Controls:** Not feasible

Table 3: Exposure Scenario Descriptions for the Use of Disulfoton (Continued)

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
Loading/Applying Formulation Using a Push-Type Granulars Spreader (11)	PHED V1.1	2 acres for agricultural, ornamental flowers/groundcover, shrubs and tree application	**Baseline:** Hand and dermal = C grades, and inhalation = B grade. Hand = 15 replicates, dermal = 0-15 replicates, and inhalation = 15 replicates. Low confidence in hand and dermal data, and high confidence in inhalation data. **PPE:** The same dermal and hand data are used as for the baseline coupled with a 50% protection factor to account for an additional layer of clothing and a 90% protection factor to account for the use of chemical resistant gloves. A 5-fold protection factor (80% PF) was applied to the inhalation data to account for use of dust mist respirator. **Engineering Controls:** Not feasible.
Loading/Applying Granulars by Hand, Shaker Can, or with a Measuring Spoon (12) (PHED values for Granular Bait Dispersed by Hand used as a surrogate for these application methods)	PHED V1.1	350 pots	**Baseline:** Dermal and Inhalation = ABC grades, both with 16 replicates. Low confidence in dermal, and medium confidence in inhalation. Hand data back-calculated from gloved data, assuming 90% PF. **PPE:** Gloved data for hands = ABC grade with 15 replicates. The dermal data are taken from the baseline coupled with a 50% PF to account for an additional layer of clothing. Both a 80% PF (dust mist mask), and 90% PF (organic vapor respirator) were applied to baseline inhalation exposure values to account for the use of respective respirators. **Engineering Controls:** Not applicable.
Applying Ready-to-Use Liquid as a Seed Treatment (13)	PHED V1.1	No Data	No Data
Flagger Exposure			
Flagging Aerial Spray Applications (14)	PHED V1.1	350 acres	**Baseline:** Hands, dermal and inhalation data = AB grades. High confidence in dermal, hands and inhalation. Hands = 30 replicates, Inhalation = 28 replicates, and dermal = 18-28 replicates. **PPE:** Dermal and hands = AB grade. Hands = 6 replicates, dermal = 18-28 replicates. Low confidence for dermal and hands data. A 50% PF was applied to baseline data to represent dust mist masks. **Engineering Controls:** Hands and dermal = ABC grade, inhalation = AB grade. Inhalation = 16 replicates, dermal = 16 replicates, and dermal = 20-31 replicates. Medium confidence in hands, dermal data, and high confidence in inhalation data. These data are based on groundboom enclosed cab data.

Table 3: Exposure Scenario Descriptions for the Use of Disulfoton (Continued)

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
Flagging Aerial Granular Applications (15)	PHED V1.1	350 acres	**Baseline:** Hands and dermal = ABC grades. Dermal = 16-20 replicates, and hands = 4 replicates. Dermal values based on total deposition data assuming 50% PF applied to no clothes values. Inhalation = E grade with 4 replicates. Low confidence in all values. **PPE:** Dermal value based on 50% PF over baseline to account for double layer of clothes. Hands values based on 90% PF over baseline to account for use of gloves, and inhalation values based on 50% PF over baseline to account for use of dust mist mask. **Engineering Controls:** Hands, dermal and inhalation = AB grades with high confidence. Hands = 24 replicates, dermal = 27 to 30 replicates and inhalation = 37 replicates. All data based on granular drop type tractor drawn spreader enclosed cab.

Footnotes:

[a] All *Standard Assumptions* are based on an 8-hour work day as estimated by HED.

[b] All handler exposure assessments in this document are based on the "Best Available" data as defined by the PHED SOP for meeting Subdivision U Guidelines (i.e., completing exposure assessments). Best available grades are assigned to data as follows: matrices with A and B grade data (i.e., Acceptable Grade Data) and a minimum of 15 replicates; if not available, then grades A, B and C data and a minimum of 15 replicates; if not available, then all data regardless of the quality (i.e., All Grade Data) and number of replicates. High quality data with a protection factor take precedence over low quality data with no protection factor. Generic data confidence categories are assigned as follows:

High = grades A and B and 15 or more replicates per body part
Medium = grades A, B, and C and 15 or more replicates per body part
Low = any run that included D or E grade data or has less than 15 replicates per body part.

Table 4. Occupational Handler Dermal and Inhalation Exposures to Disulfoton at Baseline

Exposure Scenario (Scenario #)	Baseline Dermal Unit Exposure[a] (mg/lb ai)	Baseline Inhalation Unit Exposure[b] (g/lb ai)	Range of Application Rates[c] (lb ai/acre)	Crop Type or Target[d]	Amount Handled per Day[e]	Daily Dermal Exposure[f] (mg/day)	Daily Inhalation Exposure[g] (mg/day)
Mixer/Loader Exposure							
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Aerial/Chemigation Application (1a)	2.9	1.2	3 lb ai/acre (chemigation only)	Ag (potatoes)	350 acres	3,000	1.3
			1 lb ai/acre	Ag (barley)		1,000	0.42
			0.5 lb ai/acre	Ag (sorghum)		510	0.21
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Groundboom Application (1b)	2.9	1.2	4 lb ai/acre	Ag (potatoes)	80 acres	930	0.38
			1 lb ai/acre	Ag (wheat)		230	0.096
			0.5 lb ai/acre	Ag (sorghum)		120	0.048
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Orchard Airblast Sprayer Application (1c)	2.9	1.2	3 lb ai/acre	Ag (pecans)	40 acres	350	0.14
Loading Granulars for Aerial Application (2a)	0.0084	1.7	2 lb ai/acre	Ag (cotton)	350 acres	5.9	1.2
			1 lb ai/acre	Ag (barley)		2.9	0.60
Loading Granulars for Tractor-Drawn Spreader Application (2b)	0.0084	1.7	8 lb ai/acre	Ag (raspberries)	80 acres	5.4	1.1
			4 lb ai/acre	Ag (potatoes)		2.7	0.54
			1 lb ai/acre	Ag (cabbage)		0.67	0.14
			3 lb ai/acre	Nut Trees	2 acres	0.050	0.010
			102 lb ai/acre[h]	Non-Bearing Fruit Trees		1.7	0.35
			28.6 lb ai/acre	Flowers/Groundcover		0.48	0.097

Table 4. Occupational Handler Dermal and Inhalation Exposures to Disulfoton at Baseline (Continued)

Exposure Scenario (Scenario #)	Baseline Dermal Unit Exposure[a] (mg/lb ai)	Baseline Inhalation Unit Exposure[b] (g/lb ai)	Range of Application Rates[c] (lb ai/acre)	Crop Type or Target[d]	Amount Handled per Day[e]	Daily Dermal Exposure[f] (mg/day)	Daily Inhalation Exposure[g] (mg/day)
Applicator Exposure							
Applying Sprays with a Fixed-Wing Aircraft (3)	No Data See Eng. Control	No Data See Eng. Control	1 lb ai/acre	Ag (barley)	350 acres	See Eng. C.	See Eng. C.
			0.5 lb ai/acre	Ag (sorghum)		See Eng. C.	See Eng. C.
Applying Granulars with a Fixed-Wing Aircraft (4)	No Data See Eng. Control	No Data See Eng. Control	2 lb ai/acre	Ag (cotton)	350 acres	See Eng. C.	See Eng. C.
			1 lb ai/acre	Ag (barley)		See Eng. C.	See Eng. C.
Applying Sprays with a Helicopter (5)	No Data See Eng. Control	No Data See Eng. Control	1 lb ai/acre	Ag (barley)	350 acres	See Eng. C.	See Eng. C.
			0.5 lb ai/acre	Ag (sorghum)		See Eng. C.	See Eng. C.
Applying Granulars with a Helicopter (6)	No Data See Eng. Control	No Data See Eng. Control	2 lb ai/acre	Ag (cotton)	350 acres	See Eng. C.	See Eng. C.
			1 lb ai/acre	Ag (barley)		See Eng. C.	See Eng. C.
Applying Sprays with a Groundboom (7)	0.014	0.74	4 lb ai/acre	Ag (potatoes)	80 acres	4.5	0.24
			1 lb ai/acre	Ag (wheat)		1.1	0.059
			0.5 lb ai/acre	Ag (sorghum)		0.56	0.03
Applying Sprays to Orchards with an Airblast (8)	0.36	4.5	3 lb ai/acre	Ag	40 acres	43	0.54
Applying Granulars with a Tractor-Drawn Spreader (9)	0.0099	1.2	8 lb ai/acre	Ag (raspberries)	80 acres	6.3	0.77
			4 lb ai/acre	Ag (potatoes)		3.2	0.38
			1 lb ai/acre	Ag (cabbage)		0.79	0.096
			3 lb ai/acre[h]	Nut Trees	2 acres	0.059	0.0072
			102 lb ai/acre[h]	Non-Bearing Fruit Trees		2.0	0.24

Table 4. Occupational Handler Dermal and Inhalation Exposures to Disulfoton at Baseline (Continued)

Exposure Scenario (Scenario #)	Baseline Dermal Unit Exposure[a] (mg/lb ai)	Baseline Inhalation Unit Exposure[b] (g/lb ai)	Range of Application Rates[c] (lb ai/acre)	Crop Type or Target[d]	Amount Handled per Day[e]	Daily Dermal Exposure[f] (mg/day)	Daily Inhalation Exposure[g] (mg/day)
			28.6 lb ai/acre	Flowers/Groundcover		0.57	0.069
Mixer/Loader/Applicator Exposure							
Loading/Applying Granulars Using a Belly Grinder (10)	10	62	4 lb ai/acre	Ag (strawberries)	2 acres	80	0.50
			1 lb ai/acre	Ag (spinach)		20	0.12
			28.6 lb ai/acre	Flowers/Groundcover	2 acres	570	3.5
Loading/Applying Granulars with a Push-Type Granular Spreader (11)	2.9	6.3	3 lb ai/acre	Nut Trees	2 acres	17	0.038
			102 lb ai/acre[h]	Non-Bearing Fruit Trees		590	1.3
			20 lb ai/acre[i]	Shrubs/Trees (inc. Christmas Trees)		120	0.25
			4.3 lb ai/acre[j]			25	0.054
			4 lb ai/acre	Ag (strawberries)	2 acres	23	0.050
			1 lb ai/acre	Ag (spinach)		5.8	0.013
			28.6 lb ai/acre	Flowers/Groundcover	2 acres	170	0.36
Loading/Applying Granulars by Hand, with a Spoon, Shaker Can, or a Measuring Scoop (12)	100	470	0.00052 lb ai/12-inch pot	Potted Plants	350 pots	18	0.086
Applying Ready-To-Use Liquid as a Seed Treatment (13)	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Flagger Exposure							
Flagging Aerial Spray Applications (14)	0.011	0.35	1 lb ai/acre	Ag	350 acres	3.9	0.12
			0.5 lb ai/acre			1.9	0.061

Table 4. Occupational Handler Dermal and Inhalation Exposures to Disulfoton at Baseline (Continued)

Exposure Scenario (Scenario #)	Baseline Dermal Unit Exposure[a] (mg/lb ai)	Baseline Inhalation Unit Exposure[b] (g/lb ai)	Range of Application Rates[c] (lb ai/acre)	Crop Type or Target[d]	Amount Handled per Day[e]	Daily Dermal Exposure[f] (mg/day)	Daily Inhalation Exposure[g] (mg/day)
Flagging Aerial Granular Applications (15)	0.0028	0.15	2 lb ai/acre	Ag	350 acres	2.0	0.11
			1 lb ai/acre			0.98	0.053

Footnotes:

a Baseline Dermal Unit Exposure values are taken from PHED (V1.1), and represent long pants, long sleeved shirt, no gloves, open mixing/loading, and open cab tractors, as appropriate. Open cockpit data are not available.

b Baseline Inhalation Unit Exposure values are taken from PHED (V1.1), and reflect no respiratory protection.

c Application rates come from values found on disulfoton labels (EPA Reg No. 3125-307, 2935-435, 3125-172, 34704-475).

d Crop Type or Target provides a general description of the intended uses of various products containing disulfoton. Separate categories are presented because of differences in application rates and acres treated.

e Amount Handled Per Day values are from default estimates of acreage treated, or number of pots handled in a single day for each exposure scenario of concern, based on the application method.

f Daily Dermal Exposure (mg/day) = Dermal Unit Exposure (mg/lb ai) * Application Rate (lb ai/acre) * Amount Handled Per Day (acres/day).

g Daily Inhalation Exposure (mg/day) = Inhalation Unit Exposure (µg/lb ai) * (1 mg/1000 µg) Conversion * Application Rate (lb ai/acre) * Amount Handled Per Day (acres/day).

h Application rates for trees are based on planting with 10-foot centers, which is equivalent to 435 trees/acre.

I Shrubs/trees application rate is calculated on an estimates of 2-inch trunk diameter when measured 4-feet from the ground. The plantings use a 10-foot center planting which corresponds to 435 trees/shrubs per acre.

j This application rate is for coffee trees estimated to be 8-feet in height, planted with 10-foot centers.

Table 5. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton at Baseline

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)[b]	Amount Handled per Day[c]	Baseline Dermal			Baseline Inhalation		Baseline Total	
				Daily Dose (mg/kg/day)[d]	Short-term MOE[e]	Int.-term MOE[f]	Daily Dose (mg/kg/day)[g]	MOE[h]	Short-term MOE[i]	Int.-term MOE[j]
Mixer/Loader Risk										
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Aerial/ Chemigation Application (1a)	Ag (potatoes)	3 chemigation only	350 acres	44	0.009	0.002	0.018	2.5	0.009	0.002
	Ag (barley)	1		15	0.03	0.006	0.0060	7.5	0.03	0.006
	Ag (sorghum)	0.5		7.3	0.06	0.01	0.0030	15	0.06	0.01
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Ground-boom Application(1b)	Ag (potatoes)	4	80 acres	13	0.03	0.006	0.0055	8.2	0.03	0.006
	Ag (wheat)	1		3.3	0.1	0.03	0.0014	33	0.1	0.03
	Ag (sorghum)	0.5		1.7	0.2	0.05	0.00069	66	0.2	0.05
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Orchard Airblast Sprayer Application (1c)	Ag (pecans)	3	40 acres	5.0	0.08	0.02	0.0021	22	0.08	0.02
Loading Granulars for Aerial Application (2a)	Ag (cotton)	2	350 acres	0.084	4.8	1.0	0.017	2.7	1.7	0.7
	Ag (barley)	1		0.042	9.5	2.0	0.0085	5.3	3.4	1.4

Table 5. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton at Baseline (Continued)

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)[b]	Amount Handled per Day[c]	Baseline Dermal			Baseline Inhalation		Baseline Total	
				Daily Dose (mg/kg/day)[d]	Short-term MOE[e]	Int.-term MOE[f]	Daily Dose (mg/kg/day)[g]	MOE[h]	Short-term MOE[i]	Int.-term MOE[j]
Loading Granulars for Tractor-Drawn Spreader Application (2b)	Ag (raspberries)	8	80 acres	0.077	5.2	1.1	0.016	2.9	1.9	0.8
	Ag (potatoes)	4		0.038	10	2.2	0.0078	5.8	3.7	1.6
	Ag (cabbage)	1		0.0096	42	8.7	0.0019	23	15	6.3
	Nut Trees	3	2 acres	0.00072	560	120	0.00015	300	200	84
	Non-Bearing Fruit Trees	102		0.024	16	3.4	0.0050	9.1	5.8	2.5
	Flowers/ Groundcover	28.6		0.0069	58	12	0.0014	32	21	8.8
Applicator Risk										
Applying Sprays with a Fixed-Wing Aircraft (3)	Ag (barley)	1	350 acres	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.
	Ag (sorghum)	0.5								
Applying Granulars with a Fixed-Wing Aircraft (4)	Ag (cotton)	2	350 acres	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.
	Ag (barley)	1								
Applying Sprays with a Helicopter (5)	Ag (barley)	1	350 acres	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.
	Ag (sorghum)	0.5								
Applying Granulars with a Helicopter (6)	Ag	2	350 acres	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.
		1								

Table 5. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton at Baseline (Continued)

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)[b]	Amount Handled per Day[c]	Baseline Dermal			Baseline Inhalation		Baseline Total	
				Daily Dose (mg/kg/day)[d]	Short-term MOE[e]	Int.-term MOE[f]	Daily Dose (mg/kg/day)[g]	MOE[h]	Short-term MOE[i]	Int.-term MOE[j]
Applying Sprays with a Groundboom (7)	Ag (potatoes)	4	80 acres	0.064	6.3	1.3	0.0034	13	4.3	1.2
	Ag (wheat)	1		0.016	25	5.2	0.00085	53	17	4.7
	Ag (sorghum)	0.5		0.0080	50	10	0.00042	110	34	9.5
Applying Sprays to Orchards with an Airblast (8)	Ag	3	40 acres	0.62	0.6	0.1	0.0077	5.8	0.6	0.1
Applying Granulars with a Tractor-Drawn Spreader (9)	Ag (raspberries)	8	80 acres	0.091	4.4	0.9	0.011	4.1	2.1	0.8
	Ag (potatoes)	4		0.045	8.8	1.8	0.0055	8.2	4.3	1.5
	Ag (cabbage)	1		0.011	35	7.4	0.0014	33	17	6.0
	Nut Trees	3	2 acres	0.00085	470	98	0.00010	440	230	80
	Non-Bearing Fruit Trees	102		0.029	14	2.9	0.0035	13	6.7	2.4
	Flowers/ Groundcover	28.6		0.0081	49	10	0.00098	46	24	8.4
Mixer/Loader/Applicator Risk										
Loading/Applying Granulars Using a Belly Grinder (10)	Ag (strawberries)	4	2 acres	1.1	0.4	0.07	0.0071	6.4	0.3	0.07
	Ag (spinach)	1		0.29	1.4	0.3	0.0018	25	1.3	0.3
	Flowers/ Groundcover	28.6	2 acres	8.2	0.05	0.01	0.051	0.9	0.05	0.01

Table 5. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton at Baseline (Continued)

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)[b]	Amount Handled per Day[c]	Baseline Dermal			Baseline Inhalation		Baseline Total	
				Daily Dose (mg/kg/day)[d]	Short-term MOE[e]	Int.-term MOE[f]	Daily Dose (mg/kg/day)[g]	MOE[h]	Short-term MOE[i]	Int.-term MOE[j]
Loading/Applying Granulars with a Push-Type Granular Spreader (11)	Nut Trees	3	2 acres	0.25	1.6	0.3	0.00054	83	1.6	0.3
	Non-Bearing Fruit Trees	102		8.5	0.05	0.01	0.018	2.5	0.05	0.01
	Shrubs/Trees (inc. Christmas Trees)	20		1.7	0.2	0.05	0.0036	13	0.2	0.05
		4.3		0.36	1.1	0.2	0.00077	58	1.1	0.2
	Ag (strawberries)	4	2 acres	0.33	1.2	0.3	0.00072	63	1.2	0.3
	Ag (spinach)	1		0.083	4.8	1.0	0.00018	250	4.7	1.0
	Flowers/ Groundcover	28.6	2 acres	2.4	0.2	0.04	0.0051	8.7	0.2	0.04
Loading/Applying Granulars by Hand, with a Spoon, Shaker Can, or a Measuring Scoop (12)[m]	Potted Plants	0.00052 lb ai/12 inch pot	350 pots	0.26	1.5	0.3	0.0012	37	1.5	0.3
Applying Ready-to-Use Liquid as a Seed Treatment (13)	Ag (Cotton)	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Flagger Risk										
Flagging Aerial Spray Applications (14)	Ag (barley)	1	350 acres	0.055	7.3	1.5	0.0018	26	5.7	1.4
	Ag (sorghum)	0.5		0.028	15	3.0	0.00088	51	11	2.9
Flagging Aerial Granular Applications (15)	Ag (cotton)	2	350 acres	0.028	14	3.0	0.0015	30	9.7	2.7
	Ag (barley)	1		0.014	29	6.0	0.00075	60	19	5.4

Table 5. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton at Baseline (Continued)

Footnotes:

a Crop Type or Target provides a general description of the intended uses of various products containing disulfoton. Separate categories are presented because of the distinct differences in application rates and acres treated.
b Application rates come from values found on disulfoton labels. (See footnotes for Table 4 for specifics).
c Amount Handled Per Day values are from default estimates of acreage treated, or number of pots handled in a single day for each exposure scenario of concern, based on the application method.
d Baseline Daily Dermal Dose (mg/kg/day) = Daily Dermal Exposure (mg/day) / Body Weight (70 kg).
e Baseline Dermal Short-term MOE = NOEL (0.4 mg/kg/day) / Baseline Daily Dermal Dose (mg/kg/day).
f Baseline Dermal Intermediate-term MOE = NOEL (0.03 mg/kg/day) / [Baseline Daily Dermal Dose (mg/kg/day) * 0.36 Dermal Absorption Factor].
g Baseline Daily Inhalation Dose (mg/kg/day) = Daily Inhalation Exposure (mg/day) / Body Weight (70 kg)).
h Inhalation MOE = NOEL (0.045 mg/kg/day) / Baseline Daily Inhalation Dose (mg/kg/day).
I Total Short-term MOE = 1/[(1/Short-term Dermal MOE) + (1/Inhalation MOE)].
j Total Intermediate-term MOE = 1/[(1/Intermediate-term Dermal MOE) + (1/Inhalation MOE)].

Table 6. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton with Additional PPE

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)	Amount Handled per Day[b]	Dermal - Additional PPE[c]				Inhalation - Additional PPE[d]			Total - Additional PPE	
				Unit Exposure (mg/lb ai)	Daily Dose (mg/kg/day)[e]	Short-term MOE[f]	Int.-term MOE[g]	Unit Exposure (g/lb ai)	Daily Dose (mg/kg/day)	MOE[i]	Short-term MOE[j]	Int.-term MOE[k]
Mixer/Loader Risk												
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Aerial/ Chemigation Application (1a)	Ag (potatoes)	chemigation only 3	350 acres	0.017	0.26	1.6	0.3	0.24	0.0036	13	1.4	0.3
	Ag (barley)	1			0.085	4.7	1.0		0.0012	38	4.2	1.0
	Ag (sorghum)	0.5			0.043	9.4	2.0		0.00060	75	8.4	1.9
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Ground-boom Application(1b)	Ag (potatoes)	4	80 acres	0.017	0.078	5.1	1.1	0.24	0.0011	41	4.6	1.0
	Ag (wheat)	1			0.019	21	4.3		0.00027	160	18	4.2
	Ag (sorghum)	0.5			0.0097	41	8.6		0.00014	330	37	8.4
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Orchard Airblast Sprayer Application (1c)	Ag (pecans)	3	40 acres	0.017	0.029	14	2.9	0.24	0.00041	110	12	2.8
Loading Granulars for Aerial Application (2a)	Ag (cotton)	2	350 acres	0.0034	0.034	12	2.5	0.34	0.0034	13	6.2	2.1
	Ag (barley)	1			0.017	24	4.9		0.0017	26	12	4.1
Loading Granulars for Tractor-Drawn Spreader Application (2b)	Ag (raspberries)	8	80 acres	0.0034	0.031	13	2.7	0.34	0.0031	14	6.9	2.3
	Ag (potatoes)	4			0.016	26	5.4		0.0016	29	14	4.5
	Ag (cabbage)	1			0.0039	100	21		0.00039	120	54	18
	Nut Trees	3	2 acres		0.00029	NA	290		0.000029	1,600	NA	240
	Non-Bearing Fruit Trees	102			0.0099	40	8.4		0.00099	45	21	7.1

Table 6. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton with Additional PPE (Continued)

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)	Amount Handled per Day[b]	Dermal - Additional PPE[c]				Inhalation - Additional PPE[d]			Total - Additional PPE	
				Unit Exposure (mg/lb ai)	Daily Dose (mg/kg/day)[e]	Short-term MOE[f]	Int.-term MOE[g]	Unit Exposure (g/lb ai)	Daily Dose (mg/kg_h/day)	MOE[i]	Short-term MOE[j]	Int.-term MOE[k]
	Flowers/ Groundcover	28.6			0.0028	140	30		0.00028	160	76	25
Applicator Risk												
Applying Sprays with a Fixed-Wing Aircraft (3)	Ag (barley)	1	350 acres	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.
	Ag (sorghum)	0.5										
Applying Granulars with a Fixed-Wing Aircraft (4)	Ag (cotton)	2	350 acres	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.
	Ag (barley)	1										
Applying Sprays with a Helicopter (5)	Ag (barley)	1	350 acres	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.
	Ag (sorghum)	0.5										
Applying Granulars with a Helicopter (6)	Ag	2	350 acres	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.
		1										
Applying Sprays with a Groundboom (7)	Ag (potatoes)	4	80 acres	0.011	0.05	8.0	1.7	0.15	0.00069	66	7.1	1.6
	Ag (wheat)	1			0.013	32	6.6		0.00017	260	28	6.5
	Ag (sorghum)	0.5			0.0063	64	13		0.000086	530	57	13
Applying Sprays to Orchards with an Airblast (8)	Ag	3.0	40 acres	0.22	0.38	1.1	0.2	0.90	0.0015	29	1.0	0.2

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)	Amount Handled per Day[b]	Dermal - Additional PPE[c]				Inhalation - Additional PPE[d]			Total - Additional PPE	
				Unit Exposure (mg/lb ai)	Daily Dose (mg/kg/day)[e]	Short-term MOE[f]	Int.-term MOE[g]	Unit Exposure (g/lb ai)	Daily Dose (mg/kg/day)	MOE[i]	Short-term MOE[j]	Int.-term MOE[k]
Applying Granulars with a Tractor-Drawn Spreader (9)	Ag (raspberries)	8	80 acres	0.0042	0.038	10	2.2	0.24	0.0022	21	6.9	2.0
	Ag (potatoes)	4			0.019	21	4.3		0.0011	41	14	3.9
	Ag (cabbage)	1			0.0048	83	17		0.00027	160	55	16
	Nut Trees	3	2 acres	0.0042	0.00036	NA	230	0.24	0.000021	2,200	NA	210
	Non-Bearing Fruit Trees	102			0.012	33	6.8		0.00070	64	22	6.2
	Flowers/ Groundcover	28.6			0.0034	120	24		0.00020	230	77	22
Mixer/Loader/Applicator Risk												
Loading/Applying Granulars Using a Belly Grinder (10)	Ag (strawberries)	4	2 acres	17	1.9	0.2	0.04	12	0.0014	33	0.2	0.04
	Ag (spinach)	1			0.49	0.8	0.2		0.00034	130	0.8	0.2
	Flowers/ Groundcover	28.6	2 acres		14	0.03	0.006		0.0098	4.6	0.03	0.006

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)	Amount Handled per Day[b]	Dermal - Additional PPE[c]				Inhalation - Additional PPE[d]			Total - Additional PPE	
				Unit Exposure (mg/lb ai)	Daily Dose (mg/kg/day)[e]	Short-term MOE[f]	Int.-term MOE[g]	Unit Exposure (g/lb ai)	Daily Dose (mg/kg/day)	MOE[i]	Short-term MOE[j]	Int.-term MOE[k]
Loading/Applying Granulars with a Push-Type Granular Spreader (11)	Nut Trees	3	2 acres	0.73	0.063	6.4	1.3	1.3	0.00011	400	6.3	1.3
	Non-Bearing Fruit Trees	102			2.1	0.2	0.04		0.0038	12	0.2	0.04
	Shrubs/Trees (inc. Christmas Trees)	20			0.42	1.0	0.2		0.00074	61	0.9	0.2
		4.3			0.090	4.5	0.9		0.00016	280	4.4	0.9
	Ag (strawberries)	4	2 acres		0.083	4.8	1.0		0.00015	300	4.7	1.0
	Ag (spinach)	1			0.021	19	4.0		0.000037	1,200	19	4.0
	Flowers/ Groundcover	28.6	2 acres		0.60	0.7	0.1		0.0011	42	0.7	0.1
Loading/Applying Granulars by Hand, with a Spoon, Shaker Can, or a Measuring Scoop (12)	Potted Plants	0.00052 lb ai/12 inch pot	350 pots	40[l]	0.10	3.8	0.8	47 ov resp[l,m]	0.00012	370	3.8	0.8
								94 dm mask[l,m]	0.00024	180	3.8	0.8
Applying Ready-to-Use Liquid as a Seed Treatment (13)	Ag (cotton)	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Flagger Risk												
Flagging Aerial Spray Applications (14)	Ag (barley)	1	350 acres	0.010	0.050	8	1.7	0.070	0.00035	130	7.5	1.6
	Ag (sorghum)	0.5			0.025	16	3.3		0.00018	260	15	3.3
Flagging Aerial Granular Applications (15)	Ag (cotton)	2	350 acres	0.0016	0.016	25	5.2	0.030	0.00030	150	21	5.0
	Ag (barley)	1			0.0080	50	10		0.00015	300	43	10

Table 6. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton with Additional PPE (Continued)

Footnotes:

[a] Crop Type or Target provides a general description of the intended uses of various products containing disulfoton. Separate categories are presented because of the distinct differences in application rates and acres treated.

[b] Amount Handled Per Day values are from default estimates of acreage treated, or number of pots handled in a single day for each exposure scenario of concern, based on the application method.

[c] Additional PPE for all scenarios includes double layer of clothing (50% PF for clothing, except scenario 2, for which double layer data were available), and chemical resistant gloves. Flagger exposure values (scenarios 14 and 15 are based on double layer of clothing and no gloves).

[d] Additional PPE represents dust/mist respirator (5-fold PF), except for indoor application of scenario 12, which labels state use an OV respirator (10-fold PF). See footnote m below.

[e] Daily Dermal Dose (mg/kg/day) = Daily Dermal Exposure (mg/day)/ Body weight (70 kg).

[f] Short-term Dermal MOE = NOEL (0.4 mg/kg/day)/ Daily Dermal Dose (mg/kg/day).

[g] Intermediate-term Dermal MOE = NOEL (0.03 mg/kg/day)/Absorbed Daily Dermal Dose (mg/kg/day). Absorbed Dermal Dose = Daily Dermal Dose * 0.36 Dermal Absorption Factor.

[h] Daily Inhalation Dose (mg/kg/day) = Daily Inhalation Exposure (mg/day)/ Body weight (70 kg).

[I] Inhalation MOE = NOEL (0.045 mg/kg/day)/ Daily Inhalation Dose (mg/kg/day).

[j] Total Short-term MOE = 1/ [(1/ Short-term Dermal MOE) + (1/ Inhalation MOE)].

[k] Total Intermediate-term MOE = 1/ ((1/ Intermediate-term Dermal MOE) + (1/Inhalation MOE)).

[l] Unit exposure data for application of granules by hand were used as surrogate values for these scenarios.

[m] Disulfoton labels require use of an OV respirator (10-Fold PF) for indoor applications, and use of dust mist respirator for outdoor applications.

Table 7. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton with Engineering Controls

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)[b]	Amount Handled per Day[c]	Dermal - Engineering Controls[d]				Inhalation - Engineering Controls[d]			Total - Engineering Controls	
				Unit Exposure (mg/lb ai)[e]	Daily Dose (mg/kg/day)[f]	Short-term MOE[g]	Int.-term MOE[h]	Unit Exposure (g/lb ai)[e]	Daily Dose (mg/kg/day)	MOE[i]	Short-term MOE[j]	Int.-term MOE[k]
Mixer/Loader Risk												
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Aerial/ Chemigation Application (1a)	Ag (potatoes)	chemigation only 3	350 acres	0.0086	0.13	3.1	0.6	0.083	0.0012	36	2.9	0.6
	Ag (barley)	1			0.043	9.3	1.9		0.00042	110	8.6	1.9
	Ag (sorghum)	0.5			0.022	19	3.9		0.00021	220	17	3.8
Mixing/Loading Liquid		4	80 acres		0.039	10		0.083	0.00038		9.4	2.1
Concentrates) for Ground-boom Application(1b)		1			0.0098		8.5		0.000095		37	8.3
		0.5			0.0049	81	17		0.000047	950	75	17
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Orchard Airblast Sprayer Application (1c)	Ag (pecans)	3	40 acres	0.0086	0.015	27	5.7	0.083	0.00014	320	25	5.6
Loading Granulars for Aerial Application (2a)	Ag (cotton)	2	350 acres	0.00017	0.0017	240	49	0.034	0.00034	130	85	36
	Ag (barley)	1			0.00085	470	98		0.00017	260	170	72

Table 7. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton with Engineering Controls (Continued)

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)[b]	Amount Handled per Day[c]	Dermal - Engineering Controls[d]				Inhalation - Engineering Controls[d]			Total - Engineering Controls	
				Unit Exposure (mg/lb ai)[e]	Daily Dose (mg/kg/day)[f]	Short-term MOE[g]	Int.-term MOE[h]	Unit Exposure (g/lb ai)[e]	Daily Dose (mg/kg/day)	MOE[i]	Short-term MOE[j]	Int.-term MOE[k]
Loading Granulars for Tractor-Drawn Spreader Application (2b)	Ag (raspberries)	8	80 acres	0.00017	0.0016	260	54	0.034	0.00031	140	93	39
	Ag (potatoes)	4			0.00078	510	110		0.00016	290	190	78
	Ag (cabbage)	1			0.00019	2,100	430		0.000039	1,200	740	310
	Nut Trees	3	2 acres		NA	NA	NA		NA	NA	NA	NA
	Non-Bearing Fruit Trees	102			0.00050	810	170		0.000099	450	290	120
	Flowers/ Groundcover	28.6			0.00014	2,900	600		0.000028	1,600	1,000	440
Applicator Risk												
Applying Sprays with a Fixed-Wing Aircraft (3)	Ag (barley)	1	350 acres	0.0050	0.025	16	3.3	0.068	0.00034	130	14	3.3
	Ag (sorghum)	0.5			0.013	32	6.7		0.00017	260	29	6.5
Applying Granulars with a Fixed-Wing Aircraft (4)	Ag (cotton)	2	350 acres	0.0017	0.017	24	4.9	1.3	0.013	3.5	3.0	2.0
	Ag (barley)	1			0.0085	47	9.8		0.0065	6.9	6.0	4.1
Applying Sprays with a Helicopter (5)	Ag (barley)	1	350 acres	0.0019	0.0095	42	8.8	0.0018	0.0000090	5,000	42	8.8
	Ag (sorghum)	0.5			0.0048	84	18		0.0000045	10,000	84	18
Applying Granulars with a Helicopter (6)	Ag	2	350 acres		No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
		1										
Applying Sprays with a Groundboom (7)	Ag (potatoes)	4	80 acres	0.0050	0.023	18	3.6	0.043	0.00020	230	16	3.6
	Ag (wheat)	1			0.0057	70	15		0.000049	920	65	14
	Ag (sorghum)	0.5			0.0029	140	29		0.000025	1,800	130	29

Table 7. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton with Engineering Controls (Continued)

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)[b]	Amount Handled per Day[c]	Dermal - Engineering Controls[d]				Inhalation - Engineering Controls[d]			Total - Engineering Controls	
				Unit Exposure (mg/lb ai)[e]	Daily Dose (mg/kg/day)[f]	Short-term MOE[g]	Int.-term MOE[h]	Unit Exposure (g/lb ai)[e]	Daily Dose (mg/kg/day)	MOE[i]	Short-term MOE[j]	Int.-term MOE[k]
Applying Sprays to Orchards with an Airblast (8)	Ag	3	40 acres	0.14	0.24	1.7	0.3	0.45	0.00077	58	1.6	0.4
Applying Granulars with a Tractor-Drawn Spreader (9)	Ag (raspberries)	8	80 acres	0.0021	0.019	21	4.3	0.22	0.0020	22	11	3.6
	Ag (potatoes)	4			0.0096	42	8.7		0.0010	45	22	7.3
	Ag (cabbage)	1			0.0024	170	35		0.00025	180	86	29
	Nut Trees	3	2 acres		NA	NA	NA		NA	NA	NA	NA
	Non-Bearing Fruit Trees	102			0.0061	65	14		0.00064	70	33	11
	Flowers/ Groundcover	28.6			0.0017	230	49		0.00018	250	120	41
Mixer/Loader/Applicator Risk												
Loading/Applying Granulars Using a Belly Grinder (10)	Ag (strawberries)	4	2 acres	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Ag (spinach)	1										
	Flowers/ Groundcover	28.6	2 acres	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 7. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton with Engineering Controls (Continued)

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)[b]	Amount Handled per Day[c]	Dermal - Engineering Controls[d]				Inhalation - Engineering Controls[d]			Total - Engineering Controls	
				Unit Exposure (mg/lb ai)[e]	Daily Dose (mg/kg/day)[f]	Short-term MOE[g]	Int.-term MOE[h]	Unit Exposure (g/lb ai)[e]	Daily Dose (mg/kg/day)	MOE[i]	Short-term MOE[j]	Int.-term MOE[k]
Loading/Applying Granulars with a Push-Type Granular Spreader (11)	Nut Trees	3	2 acres	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Non-Bearing Fruit Trees	102		NA	NA	NA	NA	NA	NA	NA	NA	NA
	Shrubs/Trees (inc. Christmas Trees)	20		NA	NA	NA	NA	NA	NA	NA	NA	NA
		4.3										
	Ag (strawberries)	4	2 acres	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Ag (spinach)	1										
	Flowers/ Groundcover	28.6	2 acres	NA	NA	NA	NA	NA	NA	NA	NA	NA
Loading/Applying Granulars by Hand, with a Spoon, Shaker Can, or a Measuring Scoop (12)[m]	Potted Plants	0.00052 lb ai/12 inch pot	350 pots	NA	NA	NA	NA	NA	NA	NA	NA	NA
Applying Ready-to-Use Liquid as a Seed Treatment (13)	Ag (Cotton)	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Flagger Risk												
Flagging Aerial Spray Applications (14)	Ag (barley)	1	350 acres	0.0050[l]	0.025	16	3.3	0.043	0.00022	210	15	3.3
	Ag (sorghum)	0.5			0.013	32	6.7		0.00011	420	30	6.6
Flagging Aerial Granular Applications (15)	Ag (cotton)	2	350 acres	0.0021[m]	0.021	19	4.0	0.22	0.0022	20	9.9	3.3
	Ag (barley)	1			0.011	38	7.9		0.0011	41	20	6.6

Footnotes:

NA = Not Applicable

a Crop Type or Target provides a general description of the intended uses of various products containing disulfoton. Separate categories are presented because of differences in application rates and acres treated.

b Application rate taken from disulfoton labels.

c Amount Handled Per Day values are from default estimates of acreage treated, or number of pots handled in a single day for each exposure scenario of concern, based on the application method.

d Engineering Controls are: closed mixing and loading , single layer of clothing, and chemical resistant gloves (1a, b, c); Closed loading of granulars (2a, b); single layer of clothing, no gloves and enclosed cockpit or cab (3,4,5,6,7, 14, and 15)

e Unit Exposure Values = From PHED V1.1 dated May 1997.

f Daily Dose (mg/kg/day) = Daily Inhalation Exposure (mg/day)/ Body weight (70 kg).

g Short-term Dermal MOE = LOEL (0.4 mg/kg/day)/ Daily Dermal Dose (mg/kg/day).

h Intermediate-term Dermal MOE = NOEL (0.03 mg/kg/day)/ Absorbed Daily Dermal Dose (mg/kg/day), which is Daily Dermal Dose * 0.36 (dermal absorption factor).

I Inhalation MOE = NOEL (0.045 mg/kg/day) / Daily Inhalation Dose.

j Total Short-term MOE = 1/ ((1/ Dermal MOE) + (1/ Inhalation MOE)).

k Total Intermediate-term MOE = 1/ ((1/ Dermal MOE) + (1/ Inhalation MOE)).

l Based on data for groundboom, enclosed cab.

m Based on data for granular drop type tractor-drawn spreader, enclosed cab.

Handler Exposure and Risk Estimates for Cancer

Summary of Risk Concerns for Handlers, Data Gaps, and Confidence in Exposure and Risk Estimates

Handler Scenarios with Risk Concerns

The calculations of short-term risks indicate that **total short-term MOEs** are greater than 100 at **baseline** for **none** of the assessed exposure scenarios **except** the following:

- (2b) loading granulars with a tractor-drawn spreader to nut (pecan) trees assuming an application rate of 3 lb ai/acre, applied to 2 acres per day.

- (9) applying granulars with a tractor-drawn spreader to nut (pecan) trees assuming an application rate of 3 lb ai/acre, applied to 2 acres per day.

The calculations of intermediate-term risks indicate that **total intermediate-term MOEs** are greater than 100 at **baseline** for **none** of the assessed exposure scenarios.

The calculations of short-term risks indicate that **total short-term MOEs** are greater than 100 at **with additional PPE** for **no** additional scenarios other than those mentioned above.

The calculations of short-term and intermediate-term risks indicate that **total intermediate -term MOEs** are more than 100 at **with additional PPE** for **none** of the assessed exposure scenarios **except** the following:

- (2a) loading granulars with a tractor-drawn spreader to nut (pecan) trees assuming an application rate of 3 lb ai/acre, applied to 2 acres per day.

- (9) applying granulars with a tractor-drawn spreader to nut (pecan) trees assuming an application rate of 3 lb ai/acre, applied to 2 acres per day.

The calculations of **total short-term risks** indicate that MOEs are more than **100** with **additional PPE** (Table 6) for the following additional scenarios:

- (2a) loading granulars for aerial application using a 1.0 lb ai/acre application rate.

- (2b) loading granulars for tractor-drawn spreader application to agricultural crops at application rates of 1 lb ai/acre and 4 lb ai/acre. MOEs are greater than 100 also for loading of granulars for application to non-bearing fruit trees and to flowers and groundcovers using a tractor-drawn spreader.

- (7) applying with a groundboom to agricultural crops using an application rate of 0.5 lb ai/acre.

- (9) applying granulars with a tractor-drawn spreader to flowers and groundcover using an application rate of 28.6 lb ai/acre.

The calculations of **total intermediate-term risks** indicate that MOEs are more than **100** with **additional PPE** (Table 6) for the following:

- (2b) loading granulars for tractor-drawn spreader application to agricultural crops at application rate of 1 lb ai/acre. MOEs are greater than 100 also for loading of granulars for application to non-bearing fruit trees and to flowers and groundcovers using a tractor-drawn spreader.

Data Gaps

As noted below in the data gaps discussion, several of the exposure scenarios could not be assessed due to lack of PHED surrogate data.

Data Gaps

Data gaps exist for the following scenario:

- (6) - no PHED data exist for applying granulars from helicopters.

- (16) - no PHED data exist for applying ready-to-use liquid as a seed treatment.

Data Quality and Confidence in Assessment

Several issues must be considered when interpreting the occupational exposure risk assessment. These include:

- Several handler assessments were completed using "low quality" PHED data due to the lack of a more acceptable dataset.

- Several generic protection factors were used to calculate handler exposures. These protection factors have not been completely evaluated and accepted by HED.

- Factors used to calculate daily exposures to handlers (e.g., acres treated per day and gallons of liquid applied) are based on the best professional judgement, due to a lack of pertinent data.

Chemical Studies Submitted in Support of Reregistration

MRID 422294-01

In support of the reregistration of disulfoton, Miles Inc. has submitted a study estimating handler exposures. The results were based on surrogate data derived from handler exposure studies of Terbufos, Baythroid, and Bayleton which are referenced in Table 8. Surrogate exposure estimates for foliar applications to agricultural crops were based on a study of exposure to triadimefon during ground spray applications to wheat. Exposure estimates for soil-applied granular application of disulfoton were based on a published study of exposures to terbufos during planting of corn. Surrogate exposure estimates for aerial applications of disulfoton to agricultural crops were based on a study of exposure to cyfluthrin during aerial application of Baythroid 2 insecticide to cotton.

Data from this study were not considered in estimating occupational handler doses and risks in this assessment. The application rates used in MRID 422294-01 are within the range of rates used in this assessment. The acreage treated per day values used in the Miles study are greater than default estimates typically used by EPA. A dermal NOEL of 0.4 mg/kg/day, and an inhalation NOEL of 0.045 mg/kg/day were used in this assessment, while a dermal NOEL of 0.8 mg/kg/day, and an inhalation NOEL of 0.069 mg/kg/day were used in the Miles study. The MOEs observed by the registrant (as shown in Table 8) were somewhat higher than those calculated in this assessment.

Table 8. MRID 422294-01 Results: Summary of Di-Syston® Exposure Estimates[a]

Worker Exposure Activity	Application Rate[b] (lb ai/acre)	Amount Handled per Day[c] (acres)	Dermal Exposure (Dose)[d] (g/kg/day)	Inhalation Exposure (Dose)[d] (g/kg/day)	Dermal Margin of Safety (MOE)[e]	Inhalation Margin of Safety[f]
Mixer/Loader/Applicator (in furrow planting)	0.625 (cotton)	100	6.3	1.25	127	56
	3.0 (potatoes)		30.0	6.0	27	12
Mixer/Loader (ground-rig boom)	0.625 (cotton)	100	67.5	0.38	12	184
	3.0 (potatoes)		135.0	0.75	6	93
Mixer/Loader (aerial)	0.5 (cereals & corn)	900	<103.5	<0.90	8	78
	1.0		207.0	1.8	>4	>39
Applicator (ground-rig boom)	0.625 (cotton)	100	73.7	0.38	11	184
	3.0 (potatoes)		147.5	0.75	5	93
Mixer/Loader/Applicator (ground-rig boom)	0.625 (cotton)	100	84.8	0.90	9	155
	3.0 (potatoes)		169.5	0.45	5	78
Applicator (aerial)	0.5 (cereals & corn)	900	<135.0	<0.90	6	78
	1.0		270.0	1.8	>3	>39
Flagger (aerial)	0.5 (cereals & corn)	900	<99.0	<0.90	8	78
	1.0		198.0	1.8	>4	>39

Table 8. MRID 422294-01 Results: Summary of Di-syston® Exposure Estimates (continued)

[a] Exposure estimates are presented in MRID #422294-01, and are based on the following studies:

1. Knarr, R.D. Applicator and Mixer/Loader Exposures to Triadimefon During Ground Spray Application of BAYLETON® 50 FD Fungicide to Wheat Fields. *Mills Inc. Report No. 96798*. (June 1988). *EPA MRID No. 40995921*.

2. Eberhart, D.C. Field Exposure Study: Aerial Applications of BAYTHROID® 2 on Cotton. *Miles Inc. Report No. 91768*. (March 1986). *EPA ACCESSION No. 263763*.

3. Devine, J.M.; Kinoshita, G.B.; Peterson, R.B.; Picard, G.L. Farm Worker Exposure to Terbufos [phosphorodithioc acid, s-(tert-budylthio) methyl O,O-diethyl ester] During Planting Operations of Corn. *Archives of Environmental Toxicology*. 15:113-119 (1986).

[b] Based on data from Miles, Inc. field research and marketing personnel.

[c] Based on data from Miles, Inc. field research and marketing personnel.

[d] The inhalation and dermal exposures in this study were calculated by assigning all non-detectable values a value equal to the analytical limit of detection.

[e] Based on a NOEL of 800 g/kg/day. *Miles, Inc. Report #98347*.

[f] Based on a NOEL of 69 g/kg/day. *Miles, Inc. Report #99648*.

Post-Application Exposures and Risks

Postapplication Exposure Scenarios, Data, and Assumptions:

Occupational Postapplication Exposure Scenarios and Assumptions

HED has determined that there are potential postapplication occupational exposures to individuals entering treated areas for the purpose of harvesting of nut trees (pecans); harvesting of low-growing field crops; weeding and scouting and other non-harvesting activities associated with low-growing field crops; and transplanting, harvesting, and pruning of ornamentals.

Based on these activities, four representative scenarios were evaluated using surrogate dislodgeable foliar residue data and assumptions about transfer of residues to the skin. The surrogate assessments presented in Tables 8 and 9 are based on the application rates recommended for field crops, nut trees and ornamentals on disulfoton labels, and assumptions regarding activity levels. These assumptions would be expected to bracket the reentry exposure levels anticipated from disulfoton use on these crop types. The four scenarios and assumptions addressed by the calculations are described below:

- Harvesting of nut trees (i.e., pecans);
- Harvesting activities of low growing field crops (e.g., peanuts, cotton, broccoli, cabbage);
- Non-harvesting reentry activity (scouting, hoeing, weeding) associated with applications to low growing field crops (e.g., peanuts, cotton);
- Pruning, transplanting, and bundling of flowers associated with applications to flowers, and ornamental shrub and trees.

Data Source Descriptions for Scenarios Considered

Chemical -specific postapplication exposure data have been submitted in support of the reregistration of disulfoton, however HED has found these studies to be unacceptable[5]. In lieu of these data, a surrogate rangefinder postapplication exposure assessment was conducted to determine potential occupational and residential postapplication risks from disulfoton. The intermediate term dermal toxicity value of 0.03 mg/kg/day was used to assess risks from disulfoton. A short-term dermal toxicity value of 0.4 mg/kg/day is also available for disulfoton. However, risks were evaluated for intermediate-term exposures as a conservative approach.

Chemical Studies (Postapplication)

MRID 405041-05 and MRID 404690-01

A reentry interval study was conducted to support the reregistration of disulfoton. The study evaluated dislodgeable residues of disulfoton on cotton and potatoes, and calculated reentry intervals (MRID 404690-01, and MRID 405041-05). Note that MRID 405041-05 is the same as study submission MRID 404690-0, except that MRID 404690-0 has an attached research and development phone report from Mobay Chemical Corporation summarizing a meeting between EPA personnel and Mobay personnel on the subject of reentry protocols and dislodgeable residues. The disulfoton study was conducted as a subset of MRID 404681-01 - Reentry Intervals for Azinphos-methyl, Oxydemeton-methyl, Disulfoton, and Anilazine. MRID 404681-01 was reviewed by HED and found to be unacceptable under Subdivision K Pesticide Assessment Guidelines. The study contained the following deficiencies:[5]

- QA/QC data were inadequate in regard to field recovery, laboratory recovery (with the exception of lab recovery data for soil residues), and storage stability;
- Analytic methods used for analysis of leaf wash and soil samples were not specified;
- Chromatograms were not included in the final report;
- Testing methodology was not clearly documented (i.e., application methods, plot sizes, site descriptions, leaf-punch diameter, soil characteristics, and soil extraction method);
- Lack of meteorological data and irrigation supplied at each site during the time frame of the study;
- Several discrepancies between study design and label requirements, including application rates, maximum number of applications, and intervals between applications for the representative crop groupings and the analyzed crop.

For these reasons, the data from this study were not used to calculate postapplication reentry risks. A surrogate scenario strategy was used instead.

Assumptions Used in Postapplication Exposure Calculations (Non-Cancer Risks)

The assumptions used in the calculations for occupational postapplication risks include the following items:

- Application rates used for the calculations:
    - -- Harvesting of nut trees - 3.0 lb ai/acre;

-- Harvesting of low growing field crops - 8.0 lb ai/acre and 4.0 lb ai/acre;
-- Non-harvesting activities such as weeding and scouting - 8.0 lb ai/acre and 4.0 lb ai/acre; and
-- Pruning, and transplanting of ornamental shrubs and trees - 20 lb ai/acre and 4.3 lb ai/acre.

- Transfer coefficients (Tc) are assumed to be 10,000 cm^2/hour for the harvesting of nut trees; 3,500 cm^2/hour for harvesting activities of low growing field crops; 1,500 cm^2/hour for activities such as weeding and scouting of low growing vegetables; and 7,000 cm^2/hour for high contact activities in ornamental tree and shrub nurseries such as transplanting, pruning and bundling of flowers, shrubs and trees;.

- Exposure durations assumed to be 8 hours per day.

- Dermal absorption is assumed to be 36 percent, as in the intermediate-term handler assessment.

Postapplication Exposure and Non-Cancer Risk Estimates

The intermediate-term dermal risks from disulfoton has been assessed using surrogate regression data. The DFR is derived from the application rate assuming an estimated 10 percent of the rate applied is available as initial dislodgeable residues, and an estimated 25 percent dissipates per day. These assumptions have been made taking into consideration a 2-day half-life for disulfoton and the use of soil incorporation application methods. The equations used for the calculations are presented below.

Dislodgeable foliar residues (DFRs) were calculated as follows:

$$DFR\left(\frac{g}{cm^2}\right) = AR\left(\frac{lb\ ai}{A}\right) \times CF\left(\frac{g/cm^2}{lb\ ai/A}\right) \times F \times (1 - DR)^t$$

Where:

AR	=	Application rate
CF	=	Conversion factor (11.2 ug per cm^2 per lb ai per acre)
F	=	Fraction retained on foliage (10 percent)
DO	=	Daily dissipation rate (25 percent per day)
t	=	Days after treatment

Daily Absorbed Dermal Doses were calculated as follows:

$$Dose\ (mg/kg/d) = \frac{(DFR\ (\ g/cm^2)\ x\ Tc\ (cm^2/hr)\ x\ CF\left(\frac{1\ mg}{1{,}000\ \ g}\right)\ x\ Abs\ x\ ED\ (hrs/day))}{BW\ (kg)}$$

Where:

DFR = Dislodgeable foliar residue (g/cm^2),
Tc = Transfer coefficient; 1,500 cm^2/hr for weeding, scouting of field and vegetable crops vegetables, 3,500 cm^2/hr for harvesting of low growing field crops, 7,000 cm^2/hr for the transplanting, pruning, repotting, and bundling of ornamental shrubs, trees, and flowers, and 10,000 cm^2/hr for harvesting nut trees
CF = Conversion factor (i.e., 1 mg/1,000 g)
Abs = Dermal absorption (assume 36 percent)
ED = Exposure duration; 8 hours worked per day
BW = body weight (70 kg)

MOEs were calculated as follows:

$$MOE = \frac{NOEL\ (mg/kg/day)}{Dose\ (mg/kg/day)}$$

Where:

NOEL = 0.03 mg/kg/day
Dose = calculated absorbed dermal dose

Summary of Postapplication Risks

The acceptable MOE was assumed to be 100 for disulfoton. The resulting surrogate occupational postapplication assessments as shown in Table 9 and Table 10 indicate that:

- Disulfoton MOEs equal or exceed 100 for non-harvesting activities associated with agricultural crops (with a dermal transfer of 1,500 cm^2/hour) at the 27th day following applications at a rate of 8.0 pounds active ingredient per acre, and on the 24th day following applications at a rate of 4.0 pounds active ingredient per acre.

- Disulfoton MOEs equal or exceed 100 for harvesting activities associated with low growing field crops (with a dermal transfer of 3,500 cm^2/hour) at the 30th day following applications at a rate of 8.0 pounds active ingredient per acre, and on the 24th day following applications at a rate of 4.0 pounds active ingredient per acre.

- Disulfoton MOEs equal or exceed 100 for pruning and transplanting activities associated with ornamental shrubs, trees and flowers (with a dermal transfer of 7,000 cm^2/hour) at the 35th day following applications at a rate of 20 pounds active ingredient per acre, and on the 30th day following applications at a rate of 4.3 lb ai/acre.

- Disulfoton MOEs equal or exceed 100 for harvesting activities of nut (i.e., pecan) trees (with a dermal transfer of 10,000 cm^2/hour) at the 30th day following applications at a rate of 3.0 lb ai/acre.

Table 9. Disulfoton Intermediate-Term Surrogate Occupational Postapplication Assessment (Range Finder) for Harvesting Nut Trees and Pruning Ornamentals

Harvesting of Nut Trees - applied at 3.0 lb ai/acre				Pruning Ornamentals - applied at 20.0 lb ai/acre				Pruning Ornamentals - applied at 4.3 lb ai/acre			
DAT[a]	DFR (g/cm^2)[b]	Dermal Dose mg/kg/day	MOE	DAT[a]	DFR (g/cm^2)[b]	Dermal Dose mg/kg/day	MOE	DAT	DFR (g/cm^2)[b]	Dermal Dose mg/kg/day	MOE
0	3.4	1.4	0.02	0	22	6.5	0.005	0	4.8	1.4	0.02
27	0.0014	5.9E-4	51	33	0.0017	4.9E-4	62	27	0.0020	5.9E-4	51
30	0.00060	2.5E-4	120	35	0.00095	2.7E-4	110	30	0.00086	2.5E-4	120

Table 10. Disulfoton Intermediate-Term Surrogate Occupational Postapplication Assessment (Range Finder) for Low Growing Field Crops

Low Growing Field Crops - applied at 8.0 lb ai/acre						Low Growing Field Crops - applied at 4.0 lb ai/acre					
DAT[a]	DFR (g/cm^2)[b]	Harvesting		Non-harvesting		DAT[a]	DFR (g/cm^2)[b]	Harvesting		Non-harvesting	
		Dermal Dose mg/kg/day	MOE	Dermal Dose mg/kg/day	MOE			Dermal Dose mg/kg/day	MOE	Dermal Dose mg/kg/day	MOE
0	9.0	1.3	0.02	0.55	0.05	0	4.5	0.65	0.05	0.28	0.1
24	0.0090	1.3E-3	23	5.6E-4	54	22	0.0080	0.0011	26	0.00049	61
27	0.0038	5.5E04	55	2.3E-4	130	24	0.0045	6.5E-4	46	0.00028	110
30	0.0016	2.3E-4	130	NA	NA	27	0.0019	2.7E-4	110	NA	NA

a DAT is "days after treatment."
b Initial DFR = Application rate x Conversion factor (lb ai/acre = 11.209 g/cm^2) x fraction of initial ai retained on foliage.

Residential and Other Non-Occupational Exposures and Risks

HED has determined that residential and other non-occupational handlers are likely to be exposed during disulfoton use. The anticipated use patterns and current labeling indicate several major exposure scenarios based on the types of equipment that potentially can be used to make disulfoton applications. These scenarios include: (1) loading/applying granulars with a belly grinder; (2) loading/applying with a push type granular spreader; (3) loading/applying granulars with a spoon, shaker can, measuring scoop, or by hand; (4) application of insecticidal spikes.

Residential Handler Exposure Scenarios-Data and Assumptions

Residential handler exposure assessments were completed by HED using a baseline exposure scenario. PHED values used to estimate daily unit exposure values were taken from the *Standard Operating Procedures (SOPs) for Residential Exposure Assessments* document dated December 1997.[5] Table 11 summarizes the caveats and parameters specific to the surrogate data used for each scenario and corresponding exposure/risk assessment. The following assumptions and factors were used in order to complete this exposure assessment:

- Calculations are completed at the maximum application rates for specific crops recommended by the available disulfoton labels to bracket risk levels associated with the various use patterns. No use data were provided by the registrant concerning the actual application rates that are commonly used for disulfoton.

- Generally, the use of PPE and engineering controls are not considered acceptable options for products sold for use by homeowners because they are not available, and/or inappropriate for the exposure scenario (e.g., acceptability rationale is based on a lack of enforcement, available PPE, and training).

- PHED values represent a handler wearing typical residential clothing attire of short sleeve shirt, short pants and no gloves.

- The number of rose bushes assumed for treatment per day by a homeowner is 50 rose bushes.

- The number of pots treated per day by a homeowner is 20 six inch pots.

- The number of ornamental shrubs or trees treated per day by a homeowner is assumed to be 25.

- The area treated with granulars for flower or vegetable gardens by a homeowner is assumed to be 1,000 ft^2. For pre-planting treatment of flower and vegetable gardens with a belly grinder, the treatment area is assumed to be 10,000 ft^2.

Residential Handler Exposure and Non-Cancer Risk Estimates

The calculations of daily dermal and inhalation exposure, short-term doses, and total short-term MOEs were made using the same formulas as presented earlier for occupational handlers.

Table 12 presents residential dermal and inhalation exposures associated with the handling of disulfoton. Table 13 presents the short-term dermal and inhalation risks as well as total MOEs resulting from those exposures.

Table 11. Residential Exposure Scenario Descriptions for the Use of Disulfoton

Exposure Scenario (Number)	Data Source	Standard Assumptions[a]	Comments[b]
Mixer/Loader/Applicator Descriptors			
Loading/Applying Granulars Using a Belly Grinder (1)	SOPs for Residential Exposure Assessments (12/97)	10,000 ft^2 for pre-planting of flower/vegetable gardens	**Baseline:** Dermal and hands data = ABC grades, inhalation = AB grade. Dermal 20-45 replicates; hands = 23 replicates; and inhalation = 40 replicates. Medium confidence for hands and dermal, and high confidence for inhalation. **PPE and Engineering Controls**: Not required for assessment.
Loading/Applying Using a Push-type Granular Spreader (2)	SOPs for Residential Exposure Assessments (12/97)	10,000 ft^2 for vegetable gardens, 1,000 ft^2 for flower gardens, and 25 shrubs	**Baseline:** Hands = C grade, and inhalation data = B grade. Hand = 15 replicates; dermal = 0-15 replicates; and inhalation = 15 replicates. Low confidence in hands and dermal data, and high confidence in inhalation data.. A 50% protection factor was used to "backcalculate" a short sleeved shirt value from long sleeve shirt data. **PPE and Engineering Controls**: Not required for assessment.
Loading/Applying Granulars by Spoon, Shaker Can, Measuring Scoop, or by Hand (3) (PHED values for Granular Bait Dispersed by Hand used as a surrogate for these application methods)	SOPs for Residential Exposure Assessments (12/97)	50 rose bushes, 1,000 ft^2 for vegetable gardens, 1,000 ft^2 for flower gardens, and 25 shrubs	**Baseline:** Dermal, hands and inhalation data = ABC grade. Hands, dermal and inhalation = 16 replicates. Medium confidence in all data. A 90% PF was applied to gloved hands data to backcalculate "no glove" hand exposure. **PPE and Engineering Controls**: Not required for assessment
Application of Insecticidal Spikes (4)	NA	NA	**No Data**

[a] Standard Assumptions based on HED estimates.

[b] "Best Available" grades are defined by HED SOP for meeting Subdivision U Guidelines. Best available grades are assigned as follows: matrices with grades A and B data and a minimum of 15 replicates; if not available, then grades A, B and C data and a minimum of 15 replicates; if not available, then all data regardless of the quality and number of replicates. Data confidence are assigned as follows:
High = grades A and B and 15 or more replicates per body part
Medium = grades A, B, and C and 15 or more replicates per body part
Low = grades A, B, C, D and E or any combination of grades with less than 15 replicates

NA = Not Applicable

Table 12: Residential Handler Dermal and Inhalation Exposures to Disulfoton at Baseline

Exposure Scenario (Scenario #)	Baseline Dermal Unit Exposure (mg/lb ai)[a]	Baseline Inhalation Unit Exposure (µg/lb ai)[b]	Range of Application Rates[c]	Crop Type or Target[d]	Amount Handled Per Day[e]	Daily Dermal Exposure[f] (mg/day)	Daily Inhalation Exposure[g] (mg/day)
Mixer/Loader/Applicator Exposure							
Loading/Applying Granulars with a Belly Grinder[h] (1)	110	62	0.2 lb ai/1000 ft^2	Flower/Vegetable Gardens (pre-planting)	10,000 $ft.^2$	220	0.12
			0.1 lb ai/1000 ft^2			110	0.062
Loading/Applying Granulars with a Push Type Spreader (2)	3	6.3	0.00188 lb ai/bush	Roses	50 bushes	0.28	0.00059
			0.1125 lb ai/1,000 ft^2[j]	Vegetable Gardens	10,000 $ft.^2$	3.4	0.0071
			0.0313 lb ai/1,000 ft^2[j]			0.94	0.0020
			0.3 lb ai/1,000 ft^2	Flower Gardens	1,000 $ft.^2$	0.9	0.0019
			0.1 lb ai/1,000 ft^2			0.3	0.00063
			0.005 lb ai/1,000 ft^2			0.015	0.000032
			1.32 lb ai/4 ft. shrub	Ornamental Shrubs/ Small Trees	25 shrubs	99	0.21
			0.01 lb ai/4 ft. shrub			0.75	0.0016
			0.00032 lb ai/4 ft. shrub			0.024	0.000050
Loading/Applying Granulars with a Spoon, Shaker Can, Measuring Scoop, or by Hand[i] (3)	430	470	0.00188 lb ai/bush	Roses	50 bushes	40	0.044
			0.1125 lb ai/1,000 ft^2[j]	Vegetable Gardens	10,000 $ft.^2$	480	0.53
			0.0313lb ai/1,000 ft^2[j]			130	0.15
			0.3 lb ai/1,000 ft^2	Flower Gardens	1,000 $ft.^2$	130	0.14
			0.1 lb ai/1,000 ft^2			43	0.047
			0.005 lb ai/1,000 ft^2			2.2	0.0024
			1.32 lb ai/4 ft. shrub	Ornamental Shrubs/ Small Trees	25 shrubs	14,000	16
			0.01 lb ai/4 ft. shrub			110	0.12
			0.00032 lb ai/4 ft. shrub			3.4	0.0038
			0.00011 lb ai/6" pot	Potted Plants	20 pots	0.95	0.001
Application of Insecticidal Spikes (4)	No Data	No Data	No Data	No Data	No Data	No Data	No Data

Table 12: Residential Handler Dermal and Inhalation Exposures to Disulfoton at Baseline (Continued)

Footnotes:

[a] Baseline Dermal Unit Exposure represents short pants, short sleeved shirt, no gloves, and open mixing/loading.
[b] Baseline Inhalation Exposure represents no respirator.
[c] Application Rates are maximum rate values found on disulfoton labels (EPA Reg. No. 769-908, 572, 346, 33955-489, 4-253, 869-223, 3125-83).
[d] Crop Type or Target provides a general description of the intended uses of disulfoton. Separate categories are presented because of the distinct differences in application rates and amount handled.
[e] Daily Amount Handled values are from default estimates of square footage, or number of bushes shrubs or pots that could be treated in a single day for each exposure scenario.
[f] Daily Dermal Exposure (mg/day) = Unit Exposure (mg/lb ai) * Appl. rate * Amount Handled per day.
[g] Daily Inhalation Exposure (mg/day) = Unit Exposure (µg/lb ai) * (1mg/1000 µg) Conversion * Application Rate (lb ai/A) * Acres treated (acres/day).
[h] Residential application of disulfoton using a belly grinder are applicable for pre-plant treatment applications only.
[I] Unit exposure data for application of granules by hand were used as surrogate values for these scenarios.
[j] Application rates for small vegetable gardens are based on 24-inch row spacing (EPA Reg. No. 769-908).

Table 13: Residential Handler Short-term Risks from Disulfoton at Baseline

Exposure Scenario (Scenario #)	Crop Type or Target[a]	Amount Handled Per Day[b]	Application Rate	Baseline Dermal		Baseline Inhalation		Baseline Total
				Daily Dose (mg/kg/day)[c]	Short-term MOE[d]	Daily Dose (mg/kg/day)	Short-term MOE[f]	Short-term MOE[g]
Mixer/Loader/Applicator Risks								
Loading/Applying Granulars with a Belly Grinder (1)	Flower/Veg. Gardens (pre-planting)	10,000 ft.^{2}	0.2 lb ai/1000 ft^2	3.1	0.1	0.0017	26	0.1
			0.1 lb ai/1000 ft^2	1.6	0.3	0.00089	51	0.3
Loading/Applying Granulars with a Push Type Spreader (2)	Roses	50 bushes	0.00188 lb ai/bush	0.0040	99	8.4E-6	5,300	99
	Vegetable Gardens	10,000 ft.^{2}	0.1125 lb ai/1,000 ft^2 [h]	0.048	8.3	0.00010	440	8.2
			0.0313 lb ai/1,000 ft^2 [h]	0.013	30	0.000029	1,600	30
	Flower Gardens	1,000 ft.^{2}	0.3 lb ai/1,000 ft^2	0.013	31	0.000027	1,700	31
			0.1 lb ai/1,000 ft^2	0.0043	93	0.0000090	5,000	93
			0.005 lb ai/1,000 ft^2	0.00021	1,900	4.6E-7	98,000	1,900
	Ornamental Shrubs/ Small Trees	25 shrubs	1.32 lb ai/4 ft. shrub	1.4	0.3	0.0030	15	0.3
			0.01 lb ai/4 ft. shrub	0.011	37	0.000023	2,000	37
			0.00032 lb ai/4 ft. shrub	0.00034	1,200	7.1E-7	63,000	1,200
Loading/Applying Granulars with a Spoon, Shaker Can, Measuring Scoop, or by Hand (3)	Roses	50 bushes	0.00188 lb ai/bush	0.58	0.7	0.00063	72	0.7
	Vegetable Gardens	10,000 ft.^{2}	0.1125 lb ai/1,000 ft^2 [h]	6.9	0.06	0.0076	5.9	0.06
			0.0313lb ai/1,000 ft^2 [h]	1.9	0.2	0.0020	21	0.2
	Flower Gardens	1,000 ft.^{2}	0.3 lb ai/1,000 ft^2	1.8	0.2	0.0020	23	0.2
			0.1 lb ai/1,000 ft^2	0.61	0.7	0.00067	67	0.6
			0.005 lb ai/1,000 ft^2	0.03	13	0.000034	1,300	13
	Ornamental Shrubs/ Small Trees	25 shrubs	1.32 lb ai/4 ft. shrub	200	0.002	0.23	0.2	0.002
			0.01 lb ai/4 ft. shrub	1.5	0.3	0.0017	26	0.3
			0.00032 lb ai/4 ft. shrub	0.049	8.1	0.000054	830	8.1
	Potted Plants	20 pots	0.00011 lb ai/6" pot	0.014	30	0.000014	3,200	29

Table 13: Residential Handler Short-term Risks from Disulfoton at Baseline (Continued)

Exposure Scenario (Scenario #)	Crop Type or Target[a]	Amount Handled Per Day[b]	Application Rate	Baseline Dermal		Baseline Inhalation		Baseline Total
				Daily Dose (mg/kg/day)[c]	Short-term MOE[d]	Daily Dose (mg/kg/day)[e]	Short-term MOE[f]	Short-term MOE[g]
Application of Insecticidal Spikes (4)	Roses/Trees	No Data	No Data	No Data	No Data	No Data	No Data	No Data

Footnotes:

[a] Crop Type or Target provides a general description of the intended use of various products containing disulfoton. Separate categories are presented because of the distinct differences in application rates and acres treated.
[b] Amount Handled Per Day values are from default estimates of square footage or number of pots treated a single day for each exposure scenario of concern.
[c] Daily Dermal Dose (mg/kg/day) = Daily Dermal Exposure (mg/day)/ Body weight (70 kg).
[d] Short-term Dermal MOE = NOEL (0.4 mg/kg/day)/ Daily Dermal Dose (mg/kg/day).
[e] Daily Inhalation Dose (mg/kg/day) = Daily Inhalation Exposure (mg/day)/ Body weight (70 kg).
[f] Short-term Inhalation MOE = NOEL (0.045 mg/kg/day)/ Daily Inhalation Dose (mg/kg/day).
[g] Total Short-term MOE = 1/ [(1/ Short-term Dermal MOE) + (1/ Short-term Inhalation MOE)].
[h] Application rates for small vegetable gardens are based on 24-inch row spacing (EPA Reg No. 769-908).

Summary of Concerns for Homeowner-Handlers, Data Gaps, and Confidence in Exposure and Risk Estimates

Short-term dermal and inhalation risks for homeowner-handlers were assessed as well as the total risks associated with the handling of disulfoton

Handler Scenarios with Risk Concerns

The calculations of short-term dermal and inhalation risks indicate that **total short-term MOEs** are **greater than 100** at baseline for the following scenarios:

(2) loading/applying with a push type granular spreader to flower gardens using an application rate of 0.005 lb ai/1000 ft^2

(2) loading/applying with a push type granular spreader to ornamental shrubs and small trees using an application rate of 0.00032 lb ai/four foot shrub

Data Gaps

Data gaps exist for the following scenario:

(4) applying insecticidal spikes to rose bushes, or ornamental shrubs and trees

Data Quality and Confidence in Assessment

Several issues must be considered when interpreting the non-occupational exposure risks

- PHED hands and dermal values are ranked in the low confidence category for application with a push type granular spreader.
- Factors used to calculate daily exposures to handlers (e.g. square footage treated per day, number of pots treated and number of shrubs or trees treated in a day) are based on the best professional judgement due to a lack of pertinent data.

Non-occupational Postapplication Exposures and Risks

Residential Postapplication Exposures and Assumptions

HED has determined that there are potential postapplication exposures to residents based on the following scenarios:

- pruning, cutting, and weeding treated ornamental shrubs and trees (including rose bushes),

- pruning, cutting, weeding and irrigating treated ornamental flowers;

- harvesting and non-harvest activities such as weeding, and hoeing of home vegetable crops; and

- incidental soil ingestion.

Based on these activities, four representative scenarios were evaluated using surrogate dislodgeable foliar residue data and assumptions about transfer of residues to the skin. Transplanting and pruning ornamentals and rose bushes was not evaluated because no data were available for application rates based on a unit area basis (i.e., application rates were lbs ai per bush/shrub or per foot of bush/shrub height. The surrogate assessments presented in Table 12 are based on the application rates recommended for field crops, and flower gardens on disulfoton labels, and assumptions regarding activity levels. These assumptions would be expected to bracket the reentry exposure levels anticipated from disulfoton use on these crop types. The four scenarios and assumptions addressed by the calculations are:

- Harvesting, cutting and pruning flower gardens;

- Irrigating flower gardens;

- Harvesting of home vegetable garden crops;

- Weeding, scouting and hoeing home vegetable crops; and

- Incidental soil ingestion of soil treated flower beds or vegetable garden beds (toddlers).

Data Source Descriptions for Scenarios Considered

A surrogate postapplication exposure assessment was conducted to determine potential risks for the previously mentioned representative residential scenarios.

Assumptions Used in Post application Exposure Calculations

The assumptions used in the calculations for residential postapplication risks include the following items:

- A dermal absorption value of 36 percent and a NOEL of 0.03 mg/kg/day were used in the assessment.

- Application rates used for the calculations:

-- Harvesting, cutting and pruning flower gardens: 13.0 lb ai/acre (0.3 lb ai/1,000 $ft^{2)}$

-- Irrigating flower gardens: 13.0 lb ai/acre (0.3 lb ai/1,000 $ft^{2)}$

-- Harvesting of home vegetable garden crops: 4.9 lb ai/acre (0.1125 lb ai/1,000 $ft^{2)}$

-- Weeding and hoeing home vegetable crops: 4.9 lb ai/acre (0.1125 lb ai/1,000 $ft^{2)}$.

- Transfer coefficients (Tc) are assumed to be 10,000 cm^2/hour for high contact activities in flower gardens such as harvesting, cutting, bundling, and pruning of flowers, 1,000 cm^2/hour for activities such as irrigating flower beds, weeding and scouting of low growing vegetables, 3,500 for harvesting activities of low growing vegetable crops, and 1,500 for non-harvest activities such as weeding, and hoeing of vegetable crops.

- On the day of application, it was assumed that 10 percent of the application rate was available as initial dislodgeable residue. The dissipation rate was estimated at 25 percent per day. This assumption takes into consideration the 2-day half-life of disulfoton and the soil incorporation application techniques.

- For the soil ingestion scenario, on the day of application, it was assumed that 20 percent of the application rate is located with the soil's uppermost 1 cm. The *Residential SOP's* specify a 100 percent assumption; however after disulfoton treatment followed by soil incorporation, the insecticide should be uniformly dispersed into the top 2 inches of soil.

- The assumed soil ingestion rate for children (ages 1-6 years) was assumed to be 100 mg/day.

Postapplication Exposure and Non-Cancer Risk Estimates

The equations used for the calculations in Table 14 were the same equations as previously presented in the occupational postapplication portion of the RED with the following changes:

- ED (exposure duration) in the calculation of daily dose is 2 hours per day rather than the 8 hours per day used in the occupational postapplication assessment.

- Application rates used in the residential assessment are described above.

- Adults were assumed to weigh 70 kg. Toddlers (3 years old), used to represent the 1 to 6 year old age group, were assumed to weigh 15 kg.

- Postapplication was assessed on the same day the pesticide is applied because it was assumed that the homeowner could be exposed to soil immediately after application. Therefore, postapplication exposures were based on day 0.

Table 15 presents the postapplication risks from the incidental soil ingestion by toddlers of soil treated with disulfoton. The following equations were used:

Incidental Soil Ingestion:

$$ADD = (SR_t * IgR * CF1) / BW$$

where:

ADD	=	average daily dose (mg/kg/day)
SR_t	=	soil residue on day "t" (g/g), assuming average day of reentry "t" is day 0
IgR	=	ingestion rate of soil (mg/day), assumed to be 100 mg/day
CF1	=	weight unit conversion factor to convert the g of residues on the soil to grams to provide units of mg/day (1E-6 g/ g)
BW	=	body weight (kg), assumed 15 kg for toddlers

and

$$SR_t = AR * F * (1-D)^t * CF2 * CF3 * CF4$$

where:

AR	=	application rate (lb ai/acre)
F	=	fraction of ai available in uppermost cm of soil (fraction/cm), assumed to be 20 percent based on soil incorporation into top 2 inches of soil after application
D	=	fraction of residue that dissipates daily (unitless)
t	=	postapplication day on which exposure is being assessed
CF2	=	weight unit conversion factor to convert the lbs ai in the application rate to g for the soil residue value (4.54E8 g/lb)
CF3	=	area unit conversion factor to convert the surface area units (ft^2) in the application rate to cm^2 for the SR value (2.47E-8 acre/cm^2 if the application rate is per acre)
CF4	=	volume to weight unit conversion factor to convert the volume units (cm^3) to weight units for the SR value (0.67 cm^3/g soil)[7]
t	=	postapplication day on which exposure is being assessed, assumed to be day 0

Summary of Residential Postapplication Risks

The acceptable MOE was assumed to be 100 for disulfoton. The resulting surrogate residential postapplication assessment indicates that:

- Disulfoton MOEs equal or exceed 100 for non-harvesting activities associated with agricultural crops (with a dermal transfer of 1,500 cm^2/hour) at the 20th day following applications at a rate of 4.9 pounds active ingredient per acre.

- Disulfoton MOEs equal or exceed 100 for harvesting activities associated with vegetable crops (with a dermal transfer of 3,500 cm^2/hour) at the 23rd day following applications at a rate of 4.9 pounds active ingredient per acre.

- Disulfoton MOEs equal or exceed 100 for high contact activities such as weeding, pruning, and bundling of flowers (with a dermal transfer of 10,000 cm^2/hour) at the 30th day following applications at a rate of 13 pounds active ingredient per acre.

- Disulfoton MOEs equal or exceed 100 for irrigating flower gardens harvesting activities associated with vegetable crops (with a dermal transfer of 1,000 cm^2/hour) at the 22nd day following applications at a rate of 13 pounds active ingredient per acre.

- The disulfoton MOEs for soil ingestion were greater than 100 for vegetable garden soil (application rate 4.9 lb ai/acre), and for flower garden soil (application rate 13.0 lb ai/acre).

Table 14. Disulfoton Surrogate Postapplication Assessment (Range Finder) for Residential Application to Ornamentals and Low Growing Field Crops

Low Growing Field Crops applied at 4.9 lb ai/acre						Weeding, Pruning Flower Gardens - applied at 13 lb ai/acre					
DAT[a]	DFR (g/cm^2)[b]	Non-harvesting		Harvesting		DAT[a]	DFR (g/cm^2)	Harvesting, Weeding, Pruning, Bundling		Irrigating	
		Dermal Dose mg/kg/day	MOE	Dermal Dose mg/kg/day	MOE			Dermal Dose (mg/kg/day)[c]	MOE	Dermal Dose (mg/kg/day)[c]	MOE[d]
0	5.5	0.085	0.4	0.20	0.2	0	15	1.5	0.02	0.15	0.2
18	0.031	0.00048	63	0.0011	27	20	0.046	0.0048	6	0.00048	63
20	0.017	0.00027	110	0.00063	48	22	0.026	0.0027	11	0.00027	110
23	0.007	NA	NA	0.00027	110	30	0.0026	0.00027	110	NA	NA

a DAT is "days after treatment."
b Initial DFR = Application rate x Conversion factor (lb ai/acre = 11.209 g/cm^2) x fraction of initial ai retained on foliage.

Table 15. Residential Post-application Risks from Incidental Soil Ingestion of Disulfoton

Scenario	Receptor	Application Rate Per Treatment (AR) (lbs ai/A)[a]	SRt (ug/g)[b]	IgR (mg/day)	BW (kg)	ADD (mg/kg/day) [c]	MOE [d]
Incidental soil ingestion (Flower beds)	Toddler	13	20	100	15	0.00013	230
Incidental soil ingestion (Vegetable garden beds)	Toddler	4.9	7.4	100	15	0.000049	610

a Application rate for flower and vegetable gardens
b Soil residue (ug/g) = [AR (lbs ai/A) * 4.54E+8 ug/lb * 2.47E-8 A/cm^2 * 0.67 cm^3/g soil * 0.2/cm].
c Average daily dose (ADD) (mg/kg/day) = [SRt (ug/g) * IgR (mg/day) * g/1,000,000 ug] / [BW (kg)].
d MOE = NOEL (0.03 mg/kg/day) / ADD.

References

1) U.S. EPA 1998. Disulfoton, PC0032501: Report of Hazard Identification Assessment Review Committee dated April 9, 1998.

2) U.S. EPA 1997. Iprodione LUIS Table for Exposure Assessors (PRD report dated 11/06/96 and report run date 06/12/97.

3) Disulfoton Labels.

4) Pesticide Handler Exposure Database Version 1.1 Surrogate Exposure Table. May 1997.

5) September 27, 1991 Memo from Peg Perreault, OREB Branch to Lois Rossi, Special Review and Reregistration Division. Subject: In Depth Review of Postapplication/Reentry Data Submitted to Support the Reregistration of Azinphos-Methyl (HED Project #s 0-467, 9-0972, 8-1164, 9-0811, and 9-0812).

6) U.S. EPA 1997. Standard Operating Procedures (SOPs) for Residential Exposure Assessments. December 1997.

cc: David Anderson, OPP/HED/RRB2
OREB Files

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

March 25, 1998

MEMORANDUM

SUBJECT: Review of Disulfoton Incident Reports
DP Barcode D243921, Chemical #032501, Reregistration Case #0102

FROM: Jerome Blondell, Ph.D., Health Statistician
Chemistry and Exposure Branch 2
Health Effects Division (7509C)

Monica F. Spann, M.P.H., Environmental Health Scientist
Chemistry and Exposure Branch 2
Health Effects Division (7509C)

THRU: Susan V. Hummel, Senior Scientist
Chemistry and Exposure Branch 2
Health Effects Division (7509C)

TO: Jonathan Becker, Environmental Health Specialist
Reregistration Branch 2
Health Effects Division (7509C)

BACKGROUND

The following data bases have been consulted for the poisoning incident data on the active ingredient Disulfoton (PC Code: 032501):

1) OPP Incident Data System (IDS) - reports of incidents from various sources, including registrants, other federal and state health and environmental agencies and individual consumers, submitted to OPP since 1992. Reports submitted to the Incident Data System represent anecdotal reports or allegations only, unless otherwise stated. Typically no conclusions can be drawn implicating the pesticide as a cause of any of the reported health effects. Nevertheless, sometimes with enough cases and/or enough documentation risk mitigation measures may be suggested.

2) Poison Control Centers - as the result of Data-Call-Ins issued in 1993, OPP received Poison Control Center data covering the years 1985 through 1992 for 28 organophosphate and carbamate chemicals. Most of the national Poison Control Centers (PCCs) participate in a national data collection system, the Toxic Exposure Surveillance System which obtains data from about 70 centers at hospitals and universities. PCCs provide telephone consultation for individuals and health care providers on suspected poisonings, involving drugs, household products, pesticides, etc.

3) California Department of Food and Agriculture (replaced by the Department of Pesticide Regulation in 1991) - California has collected uniform data on suspected pesticide poisonings since 1982. Physicians are required, by statute, to report to their local health officer all occurrences of illness suspected of being related to exposure to pesticides. The majority of the incidents involve workers. Information on exposure (worker activity), type of illness (systemic, eye, skin, eye/skin and respiratory), likelihood of a causal relationship, and number of days off work and in the hospital are provided.

4) National Pesticide Telecommunications Network (NPTN) - NPTN is a toll-free information service supported by OPP. A ranking of the top 200 active ingredients for which telephone calls were received during calendar years 1984-1991, inclusive has been prepared. The total number of calls was tabulated for the categories human incidents, animal incidents, calls for information, and others.

DISULFOTON REVIEW

I. Incident Data System

Please note that the following cases from the IDS do not have documentation confirming exposure or health effects unless otherwise noted.

Incident#975-8

A pesticide incident occurred in 1994, when an individual ingested disulfoton and experienced diarrhea, ataxia, and tremors. No further information on the disposition of the case was reported.

Incident#999-104

A pesticide incident occurred in 1994, when an individual inhaled disulfoton and experienced respiratory symptoms. No further information on the disposition of the case was reported.

Incident#1097-1

A pesticide incident occurred in 1994, when a two and a half year old girl opened a product's package and put the product in her mouth. Specific symptoms were not mentioned. No further information on the disposition of the case was reported.

Incident#1358-1

A pesticide incident occurred in 1994, when an individual ingested disulfoton and experienced dizziness. No further information on the disposition of the case was reported.

Incident#3224-1

A pesticide incident occurred in 1996, when a thirty-five year old man was charged with murdering his six year old daughter and poisoning his estranged girlfriend and his two other children with disulfoton that was placed in their home. No further information on the disposition of the case was reported.

Incident#3768-1

A pesticide incident occurred in 1996, when a woman inhaled disulfoton that she had worked into the ground in the soil and experienced a sore throat and red bumps on her throat. No further information on the disposition of the case was reported.

Incident#5810-1

A pesticide incident occurred in 1997, when a farmer used disulfoton while planting cotton seeds about four years ago and experienced peripheral neuropathy, lung problems, short-term memory, a hemorrhaging stomach, and pain in his legs and knees. No further information on the disposition of the case was reported.

Incident#6248-1

A pesticide incident occurred in 1997, when a father and his son applied disulfoton to birch trees eight to ten years earlier. The son experienced arthralgia and myalgia. No further information on the disposition of the case was reported.

II. Poison Control Center Data

Disulfoton was one of 28 chemicals for which Poison Control Center (PCC) data were requested. The following text and statistics are taken from an analysis of these data; see December 5, 1994 memo from Jerome Blondell to Joshua First.

The 28 chemicals were ranked using three types of measures: (A) number and percent occupational and non-occupational adult exposures reported to PCCs requiring treatment, hospitalization, displaying symptoms or serious life-threatening effects; (B) California data for handlers and field workers comparing number of agricultural poisonings to reported applications; and (C) ratios of poisonings and hospitalization for PCC cases to estimated pounds reported in agriculture for pesticides used primarily in agriculture.

A. Occupational and Non-occupational Exposure

There were a total of 1301 disulfoton cases in the PCC data base. Of these, 59 cases were occupational exposure; 48 (81.4%) involved exposure to disulfoton alone and 11 (18.6%) involved exposure to multiple chemicals, including disulfoton. There were a total of 499 adult non-occupational exposures; 468 (93.8%) involved this chemical alone and 31 (6.2%) were attributed to multiple chemicals.[1]

In this analysis, four measures of hazard were developed based on the Poison Control Center data, as listed below.

1. Percent of all accidental cases that were seen in or referred to a health care facility (HCF).

2. Percent of these cases (seen in or referred to HCF) that were admitted for medical care.

3. Percent of cases reporting symptoms based on just those cases where the medical outcome could be determined.

4. Percent of those cases that had a major medical outcome which could be defined as life-threatening or resulting in permanent disability.

Exposure to disulfoton alone or in combination with other chemicals was evaluated for each of these categories, giving a total of 8 measures. A ranking of the 28 chemicals was done based on these measures with the lowest number being the most frequently implicated in adverse effects. Table 1 presents the analyses for occupational and non-occupational exposures.

Table 1: Measures of Risk From Occupational and Non-occupational Exposure to Disulfoton Using Poison Control Center Data from 1985-

[1] Workers who were indirectly exposed (not handlers) were classified as non-occupational cases.

1992[a]

	Occupational Exposure	Non-occupational Exposure
Percent Seen in HCF		
Single chemical exposure	62.5 (68.2)	23.9(44.0)
Multiple chemical exposure	67.8(69.8)	24.6 (46.1)
Percent Hospitalized		
Single chemical exposure	26.7*[3] (12.2)	4.5 (9.9)
Multiple chemical exposure	27.5*[3] (14.3)	6.5 (12.6)
Percent with Symptoms		
Single chemical exposure	87.9*[7] (85.8)	59.2 (74.0)
Multiple chemical exposure	90.2*[6] (85.8)	62.1 (75.2)
Percent with Life-threatening Symptoms		
Single chemical exposure	3.0*[4] (0.0)	0.0 (0.0)
Multiple chemical exposure	2.4*[5] (0.5)	0.0 (0.05)

a Extracted from Tables 2, 3, 5 and 6 in December 5, 1994 memo from Jerome Blondell to Joshua First; number in parentheses is median score for that category.
* Top 25% of chemicals are ranked with a superscript of 1 to 7

Disulfoton had the third highest percent hospitalized for occupational cases. On life-threatening symptoms, disulfoton had the fourth highest percent for a single chemical exposure and fifth highest percent for multiple chemical exposure for occupational cases. However, these percentages were based on one life-threatening case. On percent with symptoms, disulfoton had the sixth highest percent for multiple chemical exposure and seventh highest percent for single chemical exposure for occupational cases. Among non-occupational cases with sufficient numbers reported, disulfoton did not rank in the top 25% on any of the measures.

B. Ratios of poisoning - California Data

The incidence of **systemic poisoning cases** in agricultural workers reported to the California was compared to the number of applications of disulfoton. Those calculations, along with the median score for a total of 29 pesticides, are presented in the

Table 2 below.

Table 2: Systemic Poisonings/1,000 Applications in Selected Agricultural Workers Exposed to Disulfoton in California, 1982-1989[a]

Pesticide	Number of Appl.	Poisonings/1,000 Appl. (N) Primary Pesticide Only			Poisonings/1,000 Appl.(N) Multiple Pesticide Exposure		
		Handlers	Field Workers	Total	Handlers	Field Workers	Total
Disulfoton	31,226	.13 (4)	.10 (3)	.22 (7)	.26 (8)	.13 (4)	.38 (12)
Median		.21	.20	.41	.44	.50	1.02

a Extracted from Table A5 in December 5, 1994 memo from Jerome Blondell to Joshua First; number in parentheses is the observed number of poisoned cases.

Disulfoton had the eleventh highest ratio of field worker poisonings per 1,000 applications in California when exposures to mixtures were included and when mixtures were excluded (See Table 7 in the December 5, 1994 memo.)

C. Exposure in Children

A separate analysis of the number of exposures in children five years of age and under from 1985-1992 was conducted. For disulfoton, there were 743 incidents; 679 involved exposure to disulfoton alone and 64 involved other pesticides as well. Compared to 14 other organophosphates and carbamates that 25 or more children were exposed to, disulfoton cases were less than half as likely to be seen in a health care facility or require hospitalization. Symptoms also occurred less often for disulfoton, but there were two life-threatening cases reported in children under age six.

III. California Data - 1982 through 1995

Detailed descriptions of 29 cases submitted to the California Pesticide Illness Surveillance Program (1982-1995) were reviewed. In 18 of these cases, disulfoton was used alone and was judged to be responsible for the health effects. Only cases with a definite,

probable or possible relationship were reviewed. Disulfoton ranked 60th as a cause of systemic poisoning in California. Two individuals were hospitalized between 1982 and 1995. Table 1 presents the types of illnesses reported by year. Table 2 gives the total number of workers that took time off work as a result of their illness and how many were hospitalized and for how long.

Table 1: Cases Due to Disulfoton Exposure in California Reported by Type of Illness and Year, 1982-1995

Year	Illness Type					
	Systemic[a]	Eye	Skin	Resp	Combination[b]	Total
1982	1	-	-	-	-	1
1983	3	-	-	-	-	3
1984	2	-	-	-	-	2
1985	2	-	-	-	-	2
1986	-	-	-	-	-	-
1987	-	-	-	-	-	-
1988	-	-	-	-	-	-
1989	-	-	-	-	-	-
1990	1	-	-	-	-	1
1991	2	-	-	-	-	2
1992	2	1	-	-	-	3
1993	-	1	1	-	-	2
1994	2	-	-	-	-	2
1995	-	-	-	-	-	-
Total	15	2	1	-	-	18

[a] Category includes cases where skin, eye, or respiratory effects were also reported

[b] Category includes combined irritative effects to eye, skin, and

respiratory system

Table 2: Number of Persons Disabled (taking time off work) or Hospitalized for Indicated Number of Days After Disulfoton Exposure in California, 1982-1995.

	Number of Persons Disabled	Number of Persons Hospitalized
One day	2	-
Two days	1	-
3-5 days	2	1
6-10 days	1	-
more than 10 days	-	1
Unknown	1	-

A total of 15 persons had systemic illnesses or 83.3% of 18 persons. A total of 2 persons had eye illnesses or 13.3% of 18 persons. A variety of worker activities were associated with exposure to disulfoton as illustrated in Table 3 below.

Table 3: Illnesses by Activity Categories for Disulfoton Exposure in California, 1982-1995

Activity Category[a]	Illness Category					
	Systemic[b]	Eye	Skin	Resp	Combination[c]	Total
Application	4	-	1	-	-	5
Coinciden	3	-	-	-	-	3
Driftexp	1	-	-	-	-	1
Mixing/Loading	3	1	-	-	-	4
Othernon	4	1	-	-	-	5
Total	15	2	1	-	-	18

[a] Coinciden= coincidental; Driftexp= exposure to pesticide that has drifted from intended targets; Othernon= non-occupational exposure
[b] Category includes cases where skin, eye, or respiratory effects were also reported
[c] Category includes combined irritative effects to eye, skin, and

respiratory system

According to the above activity categories, application and mixing/loading were associated with the majority of the exposures. These illnesses included symptoms of weakness, nausea, blurred vision, body aches, and twitching eyes.

IV. NPTN

On the list of the top 200 chemicals for which NPTN received calls from 1984-1991 inclusively, disulfoton was ranked 55th with 68 incidents in humans reported and 22 incidents in animals (mostly pets).

V. Conclusions

In California, disulfoton had the eleventh highest ratio (1982-1989) for cases when the pesticide was considered the primary cause of poisoning of fieldworkers per 1,000 applications. Disulfoton ranked third on percentage of occupational PCC cases requiring hospitalization and fourth on percentage of occupational cases with life-threatening symptoms.

VI. Recommendations

Measures to reduce risk to applicators and handlers of disulfoton should be consistent with other organophosphate and carbamates.

cc: Correspondence
Disulfoton file (chemical no. 032501)
SRRD - Dana Lateulere

RDI: BRSrSci:SHummel: